JUNE 23, 1958 PRICE 50 CENTS

DESIGN edition

Product Engineering

ZINE OF DESIGN
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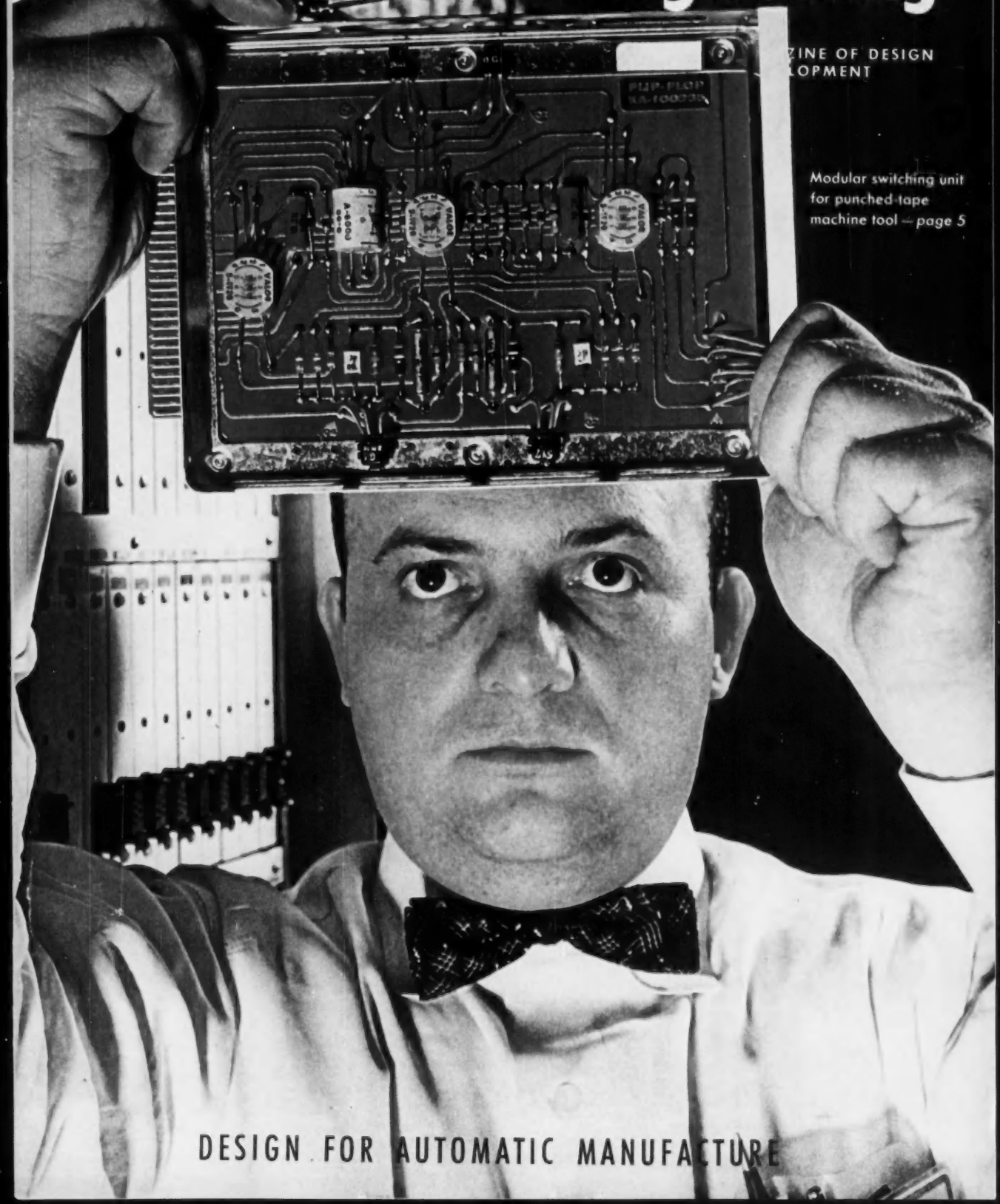

Modular switching unit for punched-tape machine tool — page 5

DESIGN FOR AUTOMATIC MANUFACTURE

VALUE ANALYSIS where it really counts ... during design!

C/R Shaft Type Oil Seal

C/R Standard End Face Seal

C/R Sirvene Diaphragm

C/R Sirvis Molded Cup

C/R Rawhide Beveled Gear

Here's an expert at work, saving you money at the right time — during design. Like all C/R sales engineers, he's an experienced, well-trained representative whose knowledge springs from a solid engineering background. His ability to sit down with you during the design phase will help develop the most efficient and economical solutions to your problems.

For example, he will often suggest design modifications that may save substantial production costs. Again, he will advise against specifications or seal types which he knows from experience will lead to service problems and user dissatisfaction. His personal "value analysis" of your fluid sealing problems, backed by the quality of these Chicago Rawhide products, can save you money. Welcome him when he calls to see you.

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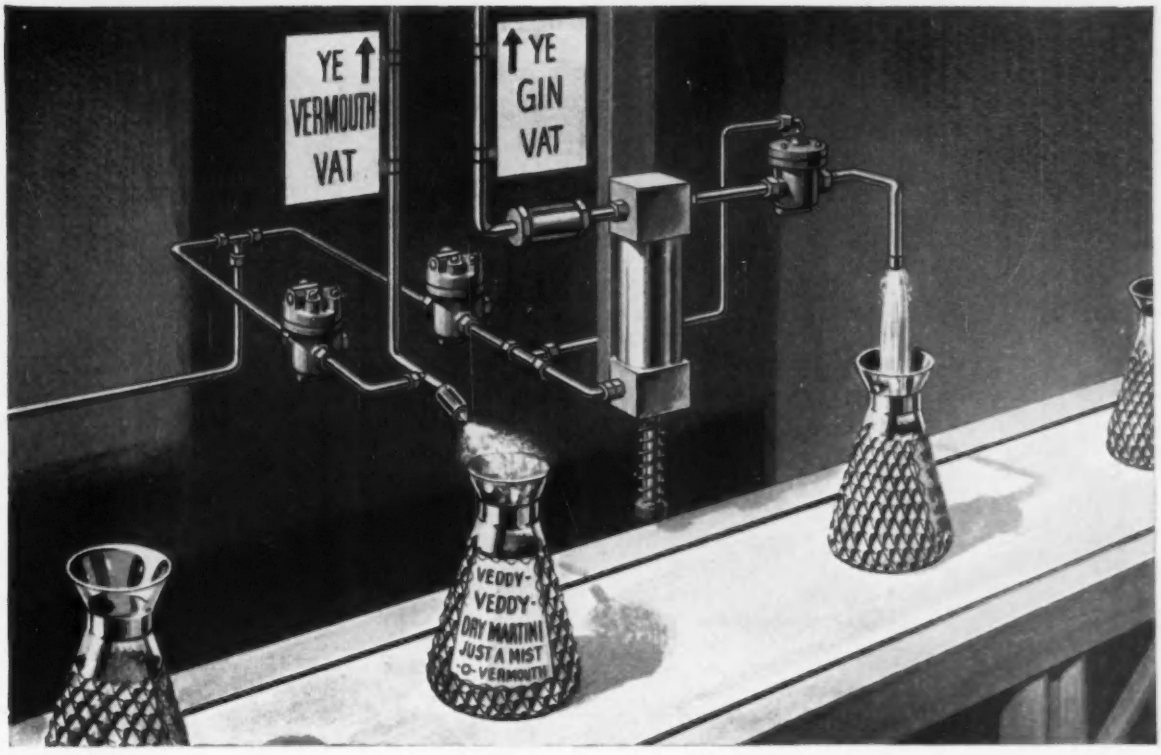


What? Air Automates the Extra, Extra-Dry Martini!

The ready mixed Martini may never come to this but . . .

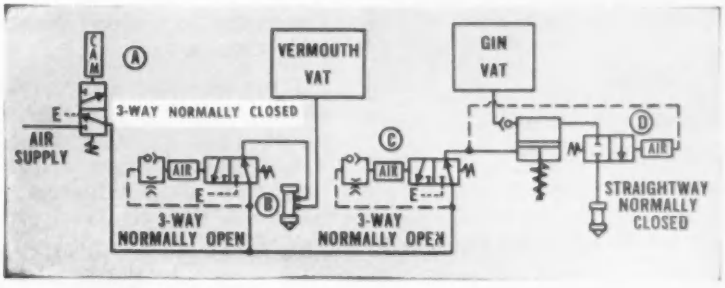
"Don't bruise the Vermouth!" Maybe you subscribe to the idea of only a fog of Vermouth or maybe you like yours four-to-one. But, if it came to bottling this vogueish mixture, the circuit here could certainly do it. Meanwhile it gives us a fanciful way to show you how you can easily create an all air circuit that does a continuous sequence of timed operations by using valves that can be both operated and sequenced by air. Every time the conveyor stops, it triggers the circuit.

Triggering one operation with another and timing the operating periods—all with air—may save the day for you.

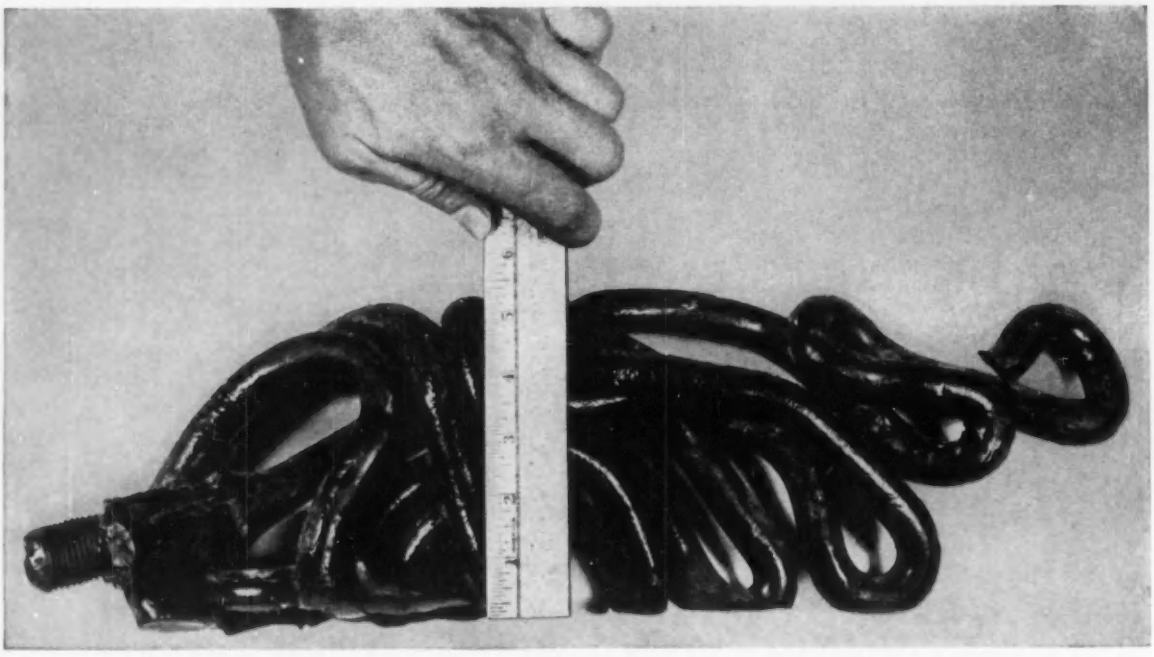
The same air involved in the main operation can also pilot these valves. What's more these valves can be preset to wait out a time delay before operating, or operate for a self-measured time. Using them you can create unlimited all-air automation systems which could just turn the trick where you wish to avoid electricity, or want to stick with just one power medium.

SEQUENCE OF OPERATION

1. Conveyor indexes, opening cam valve (A). This introduces air to valves (B) and (C) which begin timing in. Vermouth is atomized by Vermouth nozzle, cylinder expels a measured amount of gin through master valve (D) which has been opened by air from the outlet of valve (C).
2. Valves (B) and (C) time out and close, stopping liquid flow.
3. Conveyor indexes again.



Ross OPERATING VALVE CO. 114 East Golden Gate • Detroit 3, Michigan



This steel "pretzel" was 14 feet long!

Down near Caprock, New Mexico, they're still talking about it . . . the nickel alloy steel sucker rod that squashed into 18 inches.

It took an accident to demonstrate real toughness.

The sucker rod, a long shaft connecting power at the surface with a piston thousands of feet below, was operating rhythmically. Its reciprocal motion brought up oil in rich spurts.

Suddenly, part way down, the well casing broke, trapping the sucker rod. Fourteen feet of rod were quickly crammed into 18 inches. But despite violent twists the sucker rod *didn't break!* See for yourself!

Nickel alloy steel provides toughness...plus fatigue resistance

Stresses on sucker rods from the pumping motion are high, and fatigue life must be extended as far as possible even in corrosive wells. That's why this one was made of AISI 4820 steel – a high-strength nickel alloy steel containing 3.5% nickel and .25% molybdenum.

It's a quenched and tempered steel. Normally a carburizing grade, 4820 specially quenched and tempered gives excellent toughness along with through hardness and relatively high strength.

Typical mechanical properties are:

Ultimate strength	120,000 psi
Yield strength	110,000 psi
Elongation	25% in 4 x diam.
Reduction of area	68%
Brinell hardness	241
Izod impact	90 ft. lbs.

We don't know of many better illustrations of the toughness and ductility of high strength nickel alloy steels than this one.

At any rate, down near Caprock, New Mexico, they're still talking about it.

If you'd like to know more about high mechanical properties of Nickel Alloys Steels . . . their strength, toughness, ductility and resistance to corrosion fatigue, for example, send for "The Properties of Heat Treated Wrought Nickel Alloy Steels."

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

INCO NICKEL

NICKEL ALLOYS PERFORM BETTER LONGER

Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

JUNE 23, 1958 Vol. 29, No. 25

Faster Molding for Rubber Parts 68... R. L. Halstead, Ohio Rubber Co.
Automated process produces up to 200,000 top-precision pieces per day. How it works; how to design parts for it.

Predict Wear of Metal Parts 71... Ernest Rabinowicz, Massachusetts Institute of Technology
New wear coefficients give answers that can lengthen life of a sliding system. With equations and other data are included examples of applications to design problems.

Design Features in New Products 74... Transistors give desk-size computers; van pumps do auto transmission job; five hydraulic circuits for 3-job machine; conveyor kneads as it pushes.

Electrical Control Enclosures * 78... F. L. Teuscher, General Electric Co.
Besides containing, mounting and protecting controls, enclosures must meet several sets of standards. Here's a guide.

SPECIAL REPORT

DESIGN FOR AUTOMATIC PRODUCTION:

Automation is stepping out into a broader field. No longer limited to long assembly lines and mass-production output, it can also manufacture moderate or even small quantities. This results when the product—and machine to make it—are designed together in a coordinated approach to an automation problem. Three case histories tell the story:

Automatic Manufacture for High Production 82... C. L. Johnson, General Motors Corp.

Automation Conquers an Arduous Task 85... Fred Bannann, General Electric Co.

Automating a Large Low-volume Product 88... R. O. Vueilleumier, American Machine & Foundry Co.

DESIGN FILE

For Better Electroplating 94... P. C. Noy, Canadian General Electric Co.
Better mounting, drainage, radii are covered in this first of a 2-part article. Next article will deal with additional problems.

European Solder Developments 97... A foreign digest
Roundup is based on recent patents and other sources.

DEPARTMENTS

Interesting to Note	5	New Components, Materials	101
Developments to Watch	19	Catalogs and Bulletins	130
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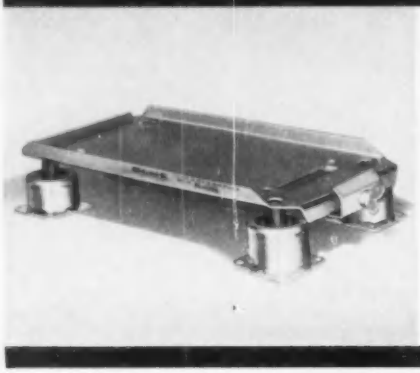
LORD electronic mounting systems

LORD designs and manufactures *complete*, assembled mounting systems in a wide range of standard and special designs. These provide excellent vibration and shock protection for airborne electronic equipment.

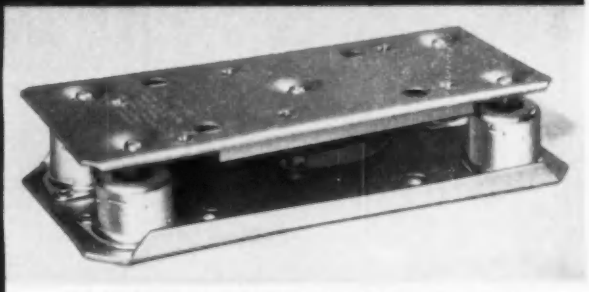
With recently expanded facilities, LORD offers outstanding service on all types of standard bases to meet all pertinent MIL specifications.

Extensive experience can be applied to the design of specialized systems to meet high-performance requirements or to withstand environmental extremes such as high temperatures, high frequencies, steady-state accelerations and transient shock conditions.

All materials and designs are selected to satisfy both performance and economical considerations. To initiate your mounting system project or obtain more information, contact your nearest LORD Field Engineer or the Home Office, Erie, Pa.

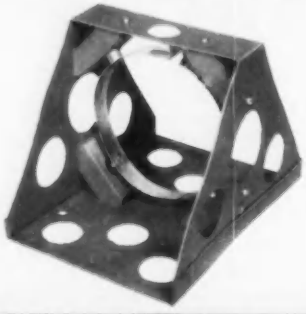


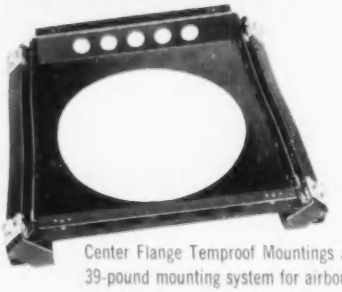
MS-91404-S1 mounting base assembly incorporates Temproof Mountings.



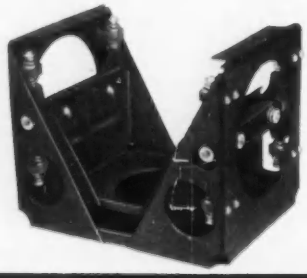
MT-1555/U base with miniature Temproof Mountings provides all-attitude protection for electronic unit.

Special all-attitude base with BTR (Broad Temperature Range) Mountings for gyro in jet-powered aircraft.



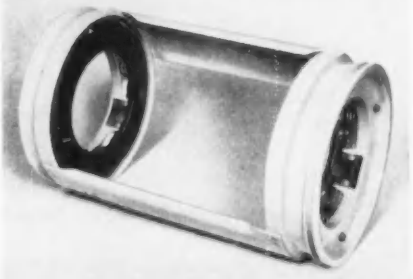


Center Flange Temproof Mountings are used in 39-pound mounting system for airborne antenna harmonizer.



Custom-designed rectilinear mounting system protects missile gyro against rotation from translational inputs.

High-performance mounting system for missile protects canister-type electronic units of modular design.



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Interesting to Note . . .

Flip-flop

While the German *Luftwaffe* was enjoying a virtual monopoly of the skies over Europe during the early 1940s, anti-Axis scientists on two continents were struggling to develop an antiaircraft weapon better than barrage balloons and ack-ack. It wasn't until near the war's end that the famous radio proximity fuse, developed by the National Bureau of Standards, was mass-produced and successfully used against aircraft, vehicles and personnel.

The key, perhaps, to the proximity fuse was a new wiring technique developed by the Centralab Division of Globe-Union, Inc. Wires, resistors and capacitors became an integral part of a thin plate of steatite ceramic. These printed circuits greatly aided the trend towards miniaturization which followed after the war.

A recent application of printed circuitry is featured on our cover. Incorporated in Hughes Aircraft Co's punched-tape-controlled line of machine tools is this transistorized "flip-flop" circuit, the most important module in the system. This one and 18 other types, in building-block fashion, make up an electronic control system shown in the background.

What Is Automation?

On the outskirts of Philadelphia in the 1780s a strange new factory began operation—a continuous-process flour mill that was completely automatic. Grain entered one hopper and came out flour on a conveyor belt without interference from human hands. Although Oliver Evans' mill was the first automated factory, it took 162 years for the term "automation" to enter the English language. In 1946, D. S. Harder, then vice-president of manufacturing at Ford Motor Co., was reviewing plans for a new plant. He said, "Let's see some more mechanical handling between those transfer machines. Give us some more of that automatic business . . . some more of that . . . that . . . automation." The word then referred to automatic work-feeding devices.

Six months later, McGraw-Hill's metalworking journal, *American Machinist*, first used the word in print, defining automation as ". . . the art of applying mechanical devices to manipulate workpieces . . . under pushbutton control at strategic locations." Ten years later, *American Machinist* in the Sept. 1957 issue, redefined automation as "The welding of production operations with handling

(Continued on page 7)

Product Engineering
A McGRAW-HILL PUBLICATION

June 23, 1958 Vol. 29, No. 25

PRODUCT ENGINEERING is published weekly, with an additional Design Digest Issue in Mid-October, by McGraw-Hill Publishing Company, Inc., James H. McGraw (1860-1948), Founder. PUBLICATION OFFICE, 99-129 North Broadway, Albany 1, N. Y. See panel right for directions regarding subscription or change in address.

EXECUTIVE, EDITORIAL, CIRCULATION and ADVERTISING OFFICES: 330 W. 42nd St., New York 36, N. Y.

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PRODUCT ENGINEERING articles are indexed in both the **Industrial Arts Index** and the **Engineering Index**. PRODUCT ENGINEERING publishes its own semi-annual index including the Design Digest Issue. Copies are obtainable on request to the Editor.

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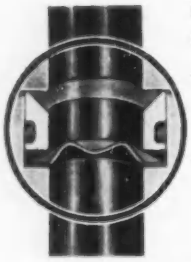
250 P. S. I. four-way air valves in ¼, ⅜ and ½ inch pipe sizes.

This is a re-design of our proven 250 P. S. I. air valve.

NEW LOW PRICE (*the result*) FACE LIFT (*the reason*)



None of the operating advantages of this rugged *'Shear-Seal'* valve has been reduced one iota!

. . . same non-corrosive construction throughout — eliminates failures due to rust.

. . . same long wearing leak-proof qualities — metal to metal *'Shear-Seal'* design is not sensitive to dirt, compensates for wear.

. . . same installation savings — because no oilers or filters are needed.

Only the exterior has been modified — tailored to the special preference of the Original Equipment Manufacturers — and, as a result, costs and prices have been substantially reduced.

Write for bulletin 5000 which includes design specs.

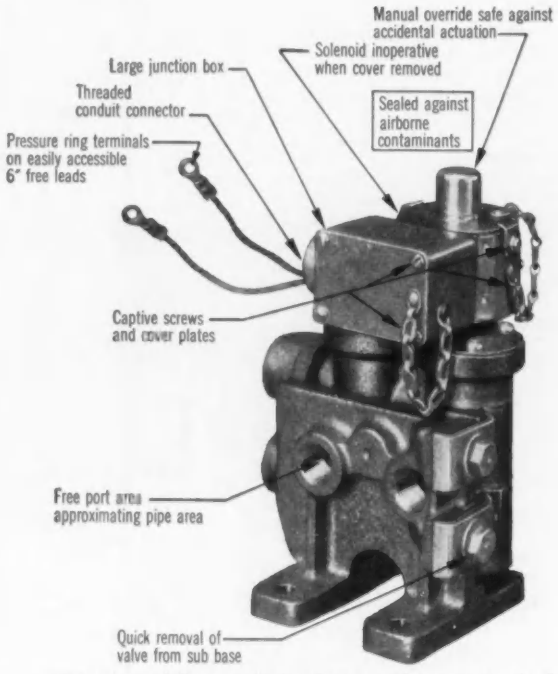
CONTROL VALVE DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

NO SOLENOID TROUBLES

with Crescent® Valves


Manual override safe against accidental actuation
Solenoid inoperative when cover removed
Large junction box
Threaded conduit connector
Sealed against airborne contaminants
Pressure ring terminals on easily accessible 6" free leads
Captive screws and cover plates
Free port area approximating pipe area
Quick removal of valve from sub base

® Product of Crescent Valve Company for the control of air, water and light oil to 150 P.S.I.

Pointed out on the photo above are the JIC features which are a must for many equipment manufacturers to gain acceptance of their machines in a growing number of production conscious plants. However, they offer obvious advantages even where they are not specifically demanded. Furthermore the JIC type Crescent solenoid is completely interchangeable with standard solenoids for the convenience of those manufacturers who want the JIC features available only for required application.

COMPETITIVE

With all its superior operating features the Crescent valve is probably the most competitively priced line on the market, particularly in the light of liberal trade and quantity discounts.

COMPACTNESS

Space, labor and materials savings have been pointed out to us by many equipment manufacturers as benefits from Crescent's compact design.

INTERCHANGEABILITY

Crescent valves can be converted to any practical current or voltage AC or DC by a simple coil change.

NO COIL BURNOUT

Short stroke, pilot operation and a generous power margin prevent overheating, overloading and the resultant coil burnout.

Write for Catalog 6-C

CONTROL VALVE DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

and control operations to tie separate pieces of automatic equipment into continuous automatic production through a series of operations, an entire line, or a complete plant."

Automatic manufacture, the next logical advance from "automation," employs much the same principles—mechanical hands do the work—but the concept is broadened to include assembly as well as production operations, and for small as well as large quantities. This is the theme of our special report on page 82.

Computers Go Literary

A group of Bedouin herdsmen took refuge in a cave during a rainstorm. By sheer coincidence one happened across an ancient jar which was one of seven containing scrolls written from 2 B.C. to 150 A.D. Before long, more scrolls and torn bits of parchment were found in the vicinity. Biblical scholars regarded the find as the greatest discovery of this century. Perhaps an entire new light would be cast on the life and times of Biblical heroes through these Dead Sea Scrolls.

Translation of the scrolls is still in progress. With thousands of fragments, some hardly legible, the job is like assembling a gigantic jig-saw puzzle. Fortunately, a new tool is available to assist the researchers piece history together. By transposing prose into a series of mathematical relationships, an IBM 705 is capable of making a qualified guess as to what words were originally written in the hundreds of mutilated sections. The computer analyzes the words preceding and following each gap. Thousands of words are then electronically scanned until the computer finds one that most nearly fits into the context. To determine the accuracy of this technique, portions of a familiar text were blocked out and fed into the machine. This experiment proved that the computer could correctly replace as many as five consecutive words. The 705 can also reveal a mathematical picture of different styles of writing, detecting what has been added by a hand that wasn't the author's.

IBM machines were first used for literary analysis in 1949 to help compile the first concordance of the complete words of St. Thomas Aquinas. Developed jointly by Father Roberto Busa, pictured above, of the Jesuit College of the Aloisianum in Gallarate, Italy, and IBM engineer Paul Tasman, the new method proved so successful that it was decided to apply it to the urgent task of cataloging the many scrolls and fragments found in the Dead Sea caves.

If you'd like programming your own literary works, a small transistorized computer for home or office is described on page 74.

The Big Little-car Race

Many years ago, an elderly lady drove her small car into an English garage. She explained to the mechanic that her car, less than a year old, was not working properly. The mechanic, after a cursory examination, explained that the valves were gummed with carbon, then noticed the hand choke fully extended. When he questioned the choke's position the woman simply explained that she didn't really know what it was for and assumed it was a convenience to hold her handbag. This scene may have occurred many times since then as the popularity of the small European cars, still favoring manual controls, goes on growing tremendously both in the US as well as abroad.

Of the small sports cars, the MGA and the Triumph are conducting a Ford-Chevy type battle to hold the lead in the registration contest this side of the Atlantic. Although first-quarter '58 figures gave the edge to MGA, 2755 to 2449, Triumph has since pulled slightly ahead. This time last year the score was 1562 to 771 in favor of MGA. A far cry from the 1,116,013 new American cars registered during the first quarter of '58, but sports cars are growing in popularity while Detroit's products have declined (off about 300,000, compared with same period last year). American auto manufacturers are eyeing the small car trend very closely. On page 24, for example, statistical calculations cite some of the reasons why domestic cars aren't selling.

Everyone seems to have an answer as to why the sports cars are so popular. Some people in Detroit say it's simply inverse snob appeal. Alan Bethell, president of Standard-Triumph Motor Co., Inc., won't deny this. But he adds that when a man drives an American car, his purported economic status is quickly evaluated. Not so with a sports car, says Bethell, at least not yet. So snob

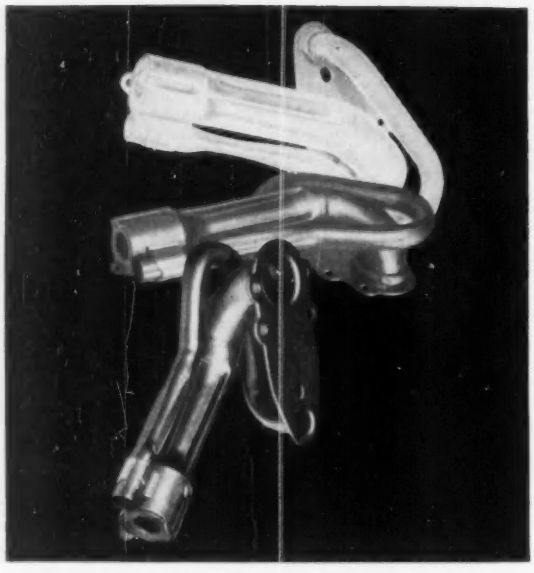
MGA Triumph—TR-3

appeal is certainly not the main reason. Spokesmen for sports cars agree that ease in handling and simplicity style are the big selling features. Economy comes late according to Bethell. Although the sports cars get more miles per gallon than the larger cars (about 30 miles/gal. for the Triumph and the MGA) the big economy feature comes in depreciation. A '57 Triumph which sold for $2600 brings anywhere from $2000 to $2300 on today's used-car block (the MGA may bring a few dollars more). The reason for slow depreciation of the small sports, according to an MGA official, is design policy. A car style remains the same until an improvement is deemed necessary, (either by the consumer or the manufacturer) then it is immediately incorporated instead of waiting for next year's model. It may be hard to tell the '58s from the '57s, but it keeps values up.

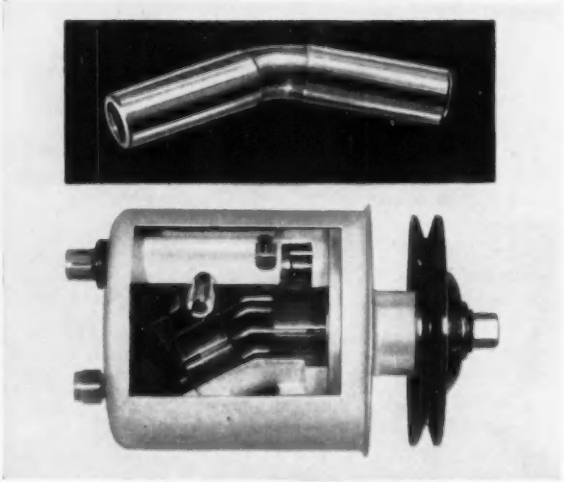
—Benedict A. Leerburger Jr.

...Flange it!
Flare it!
Bend it!
Expand it!

Republic ELECTRUNITE

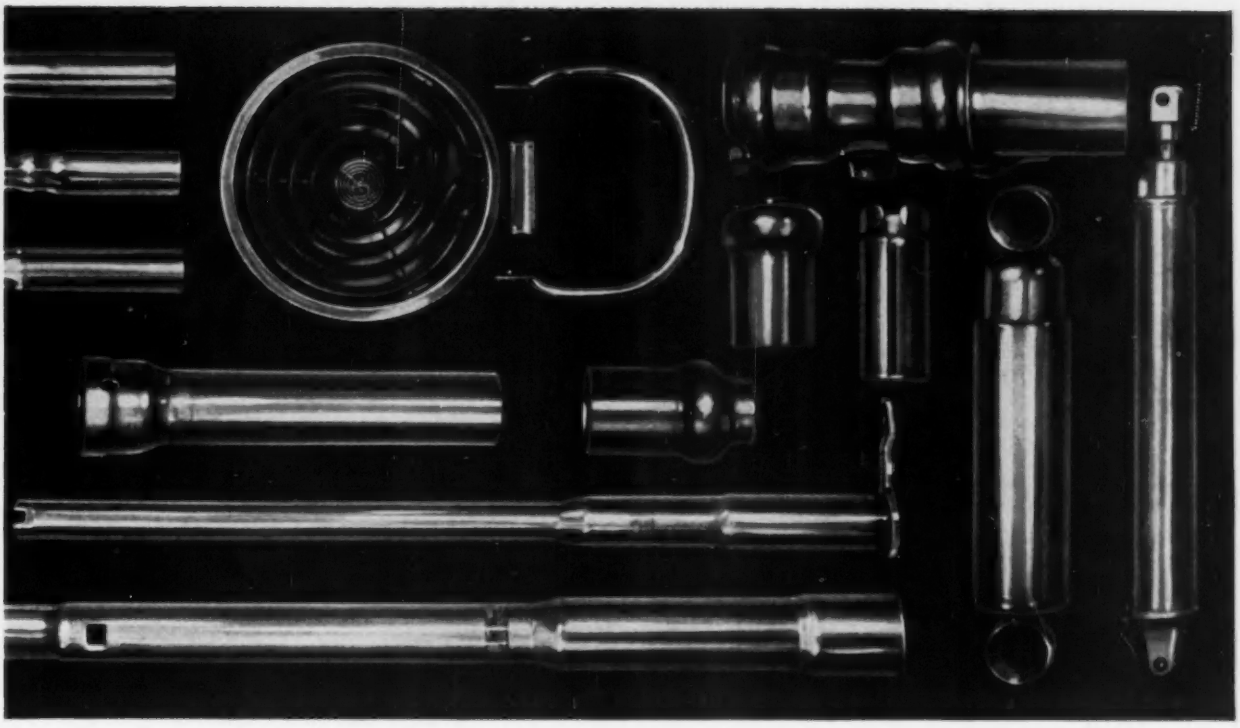


RANGE BURNER MANUFACTURER STEPS OUT with Republic ELECTRUNITE Mechanical Tubing. Harper-Wyman Company uses it in forming lightweight, easy-to-clean venturi burner tubes. The company subjects ELECTRUNITE to a hairpin bend of 1¼ diameter radius, then a four-way crimp, followed by punching, notching, and welding. Uniform, predictable ductility avoids stretch and collapse as tubing is severely bent and formed. Republic engineers will help you design ELECTRUNITE into your product to speed production, cut costs, and improve performance. Mail the coupon for facts. Or call your Republic representative.



WHEN IT'S MOVING . . . MAKE IT TUBING

Republic ELECTRUNITE meets all close tolerance requirements for new Thompson Products automotive pump. Close tolerance, uniformity, ductility, workability — four important performance requirements, all reasons why Republic ELECTRUNITE Mechanical Tubing is used in a new automotive hydraulic power pump assembly. This pump furnishes power for power steering featured by a nationally famous automobile manufacturer. Will-O-Hill Industries, Inc., Willoughby, Ohio, sub-contractor, manufacturers and specialists in close tolerance tubular stampings, cut 7/16-inch diameter ELECTRUNITE into units 2 3/16 inches long. Each unit is rolled to form a slight groove in the center and bent to an angle of exactly 150°. Nine such pieces are used in each pump assembly. For additional information, send coupon or write today.



Mechanical Tubing

fabricates easily . . . economically . . . with uniformity

Quality makes the big difference!

Republic ELECTRUNITE® Mechanical Tubing is quality-controlled from ore to finished product; produced from highest quality flat-rolled open-hearth steel made in Republic's own mills; carefully inspected to Republic's rigid requirements. Republic Tubing is welded by the exclusive ELECTRUNITE process—a continuous electric weld method that unites the wall under pressure without the addition of foreign or extra metal. Tests prove the ELECTRUNITE weld is as strong or stronger than the original base metal.

Among other advantages, this process assures uniformity of wall thickness, strength, ductility, concentricity, diameter, and physical and mechanical properties. And as the world's largest producer of specialty welded tubing, Republic has the facilities, abilities, and equipment to tailor the tube to your end use. Republic also offers complete tube fabricating facilities.

Let Republic engineers help you select the most economical ELECTRUNITE Tubing to meet your severe processing needs. Call your Republic representative or write today.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

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Please send the following information:
☐ Republic ELECTRUNITE Mechanical Tubing
☐ Fabricating Facilities
☐ Please have a Republic Engineer call

Name_____ Title_____
Firm_____
Address_____
City_____ Zone____ State_____

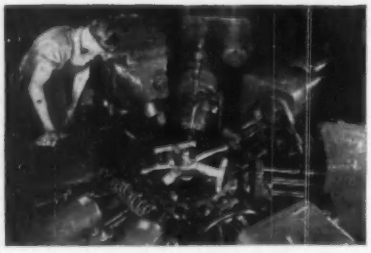
Excellent Machinability of Magnesium Cuts Production Costs

Easy machining means faster machining, less wear on tools, lower costs

Designers working in today's highly competitive markets are finding it more important than ever to consider production costs when they're selecting materials. Magnesium alloys offer much needed economies in this respect. In fact, few other structural metals are so versatile and easy to work with in production operations.

Take machining, for example.

The excellent characteristics of magnesium alloys permit machining operations at extremely high speeds—usually at the maximum obtainable speeds of



MAXIMUM OPERATING SPEEDS of automatic machine tools can be utilized in machining magnesium.

modern machine tools. Heavier depths of cut and higher rates of feed than are used on other metals are possible when machining magnesium. The life of high speed steel cutting tools when machining wrought magnesium is equal to the life of carbide tipped tools when machining other metals!

Magnesium lightness, which allows easy, efficient handling of large parts, plus excellent machining characteristics add up to substantial savings in production costs.

TURNING AND BORING. A wide range of cutting speeds, feeds and depths of cut are possible in turning and boring magnesium. Rough cuts vary from 300 fpm, 0.100 ipr and 0.800" in depth to 5,000 fpm, 0.010 ipr and 0.150" deep. Finish cuts may vary from 300 fpm, 0.025 ipr and 0.100 inches to 5,000 fpm, 0.003 ipr and 0.050 inches.

MILLING. The outstanding machining characteristics of magnesium can be used to full advantage in milling operations. Heavy feeds and milling speeds up to 9,000 fpm remove the metal rapidly with excellent surface finish.

DRILLING. The maximum speeds of standard drilling equipment can be utilized to the fullest extent. Speeds used in commercial shops on other metals are 75 to 400 fpm, but speeds up to 2,000 fpm can be used with magnesium.

SAWING. Magnesium is readily cut with band, circular, hand or power hack saws. Because of the low cutting pressure, larger cuts can be taken per tooth than are possible with other metals.

AUTOMATIC SCREW MACHINE WORK. Extruded magnesium screw machine stock is available in all common sizes and shapes. It usually costs less on a cost-per-part basis than any other metal except steel. The use of magnesium permits feeds as much as 50% to 75% higher than those used with brass. Magnesium causes less tool wear, which lowers tool cost and reduces machine down time.

It is often possible to reduce part costs because of the low power consumption, the high feeds and speeds and the excellent surface finishes that result from using magnesium. The light weight of the metal exerts less wear on spindles, belts and motors, especially where quick changes of speed are involved.

TAPPING AND THREADING. Threads which are not held to close tolerances may be tapped in magnesium alloys with standard taps. Threads may be chased in magnesium alloys at the rate of 1,000 feet per minute.

GRINDING AND POLISHING. Finish grinding of magnesium is often unnecessary inasmuch as finishing cuts give extremely accurate and smooth surfaces. Rough grinding, however, is widely used in foundry clean-up and for removing flash from die castings and forgings.

Polished surfaces of any desired quality are easy to obtain on magnesium. Surface irregularities are removed readily by polishing operations. High lustre surfaces on articles to be plated or used for decorative purposes can be produced by buffing.

In all other machining operations, such as shaping and planing, reaming, counterboring and filing, the advantages of magnesium also pay off in terms of faster production, lower costs and less tool wear. Thousands of metalworking shops are efficiently and safely working with magnesium every day. Why not consider magnesium for the products or parts you're working with now?

METAL	RELATIVE POWER REQUIREMENT
magnesium	1.0
cast aluminum	1.8
brass	2.3
cast iron	3.5
rolled aluminum	5.0
mild steel	6.3

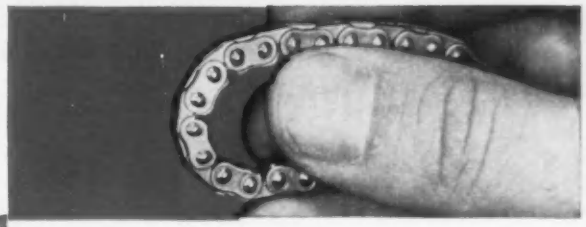
RELATIVE POWER required to machine different metals under the same conditions is shown by this comparison (1.0 = lowest power required).

MACHINING MAGNESIUM, a 60-page handbook, discusses all methods of machining mentioned above. Also includes tables on speed, feed and depths of cut, basic information on ma... 'um properties, tool design and safe procedures. For your copy, c... ...e nearest Dow office or write THE DOW CHEMICAL COMPANY, Midland, ... Department MA 1453V-1.

YOU CAN DEPEND ON DOW

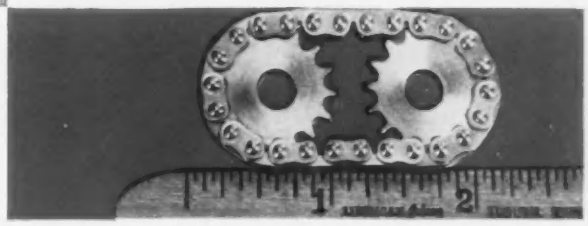
Here's full-scale efficiency in a fractional hp drive

CHAIN AS SMALL AS THIS



SPROCKETS AS SMALL AS THIS

A COMPLETE DRIVE AS SMALL AS THIS



LINK-BELT 3/16-in. pitch Silent Chain is smooth, quiet, positive at high or low speeds

Here's the ideal drive for limited-space applications. Despite its pitch of only 3/16 inches . . . weight as little as .07 pounds per foot — this durable Link-Belt drive is better than 98% efficient. In fact, it often replaces expensive, precision-cut gear trains.

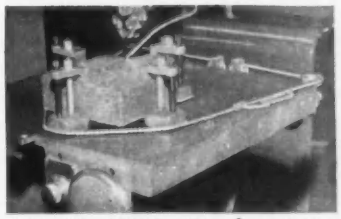
It's available in carbon and stainless steels . . . for ratios up to 12:1, speeds over 7500 rpm. Book 2510 explains outstanding features, including tooth and link form which eliminates chordal disturbance. Write for your copy to LINK-BELT COMPANY, Dept. PE, . Prudential Plaza, Chicago 1, Illinois.

Link-Belt 3/16-in. pitch silent chain is installed as original equipment on

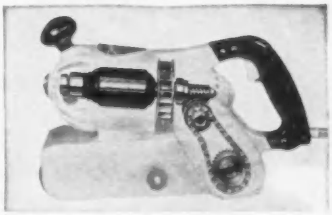
aircraft	portable planers
bread slicers	portable sanders
button making machines	radar equipment
cameras	recording machines
cigar making machines	rubber slicing machines
looms	sealing machines
meters	sewing machines
motion picture machines	timing devices
oil burners	typewriters
packaging machinery	vending machines

LINK-BELT

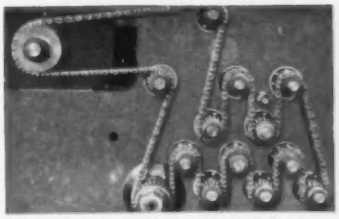
SILVERSTREAK SILENT CHAIN DRIVES



ACCURATE POWER FEED for contour shaping machine is assured by Link-Belt 3/16-in. Silverstreak silent chain.



POSITIVE POWER TRANSMISSION by Link-Belt 3/16-in. silent chain drive aids portable belt sander efficiency.

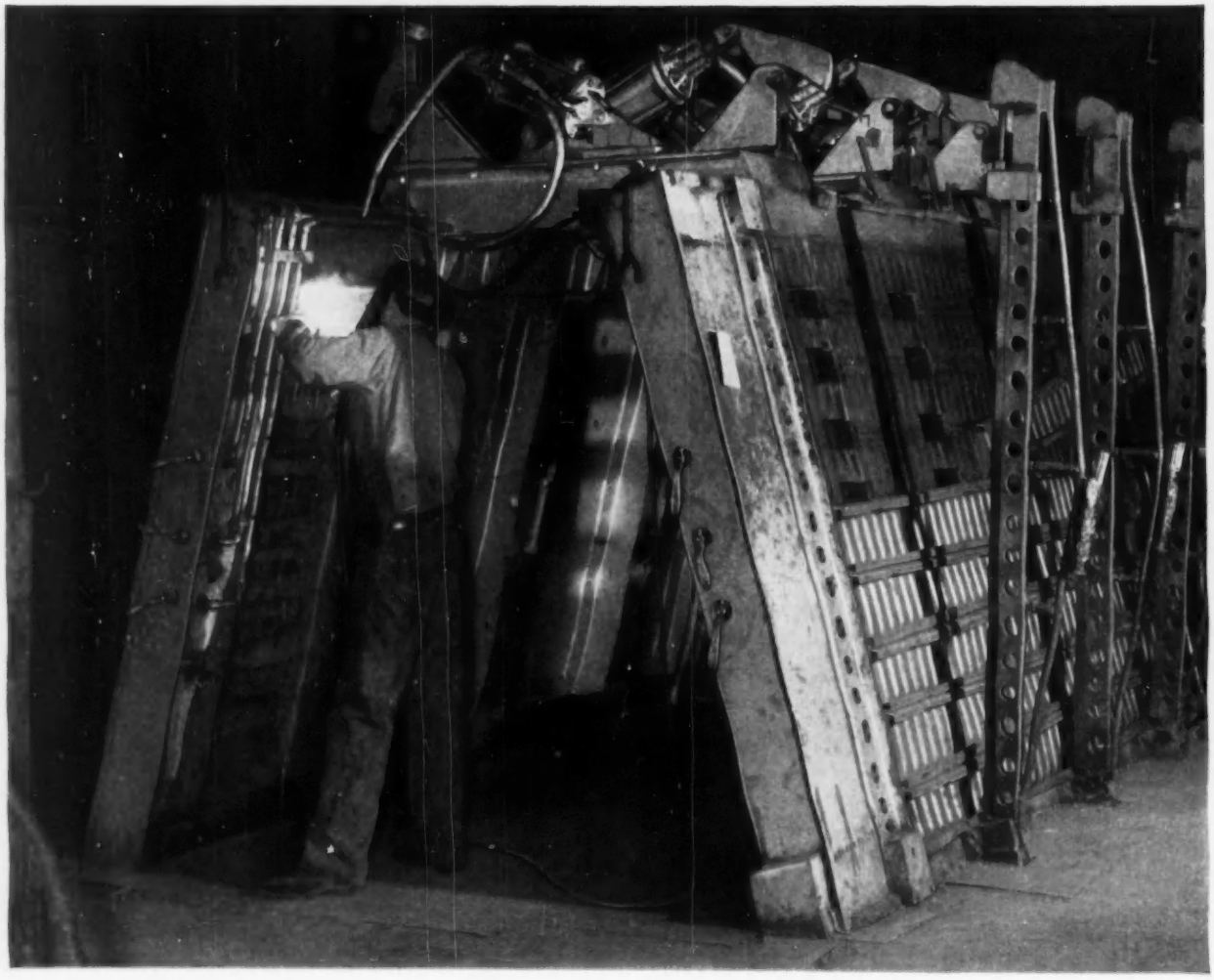


PERFECT SYNCHRONIZATION of intricate 14-wheel drive is maintained by Link-Belt 3/16-in. Duplex silent chain.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14,251

For whatever you make...

N-A-X® HIGH-TENSILE STEEL BUILDS IN STRENGTH WITH LONGER LIFE



12 CIRCLE 109 READER SERVICE CARD

Today's emphasis on fast mechanized freight car loading and unloading brings the superior qualities of N-A-X HIGH-TENSILE steel into sharp focus.

For boxcar flooring, increased mechanization means bigger, heavier and faster moving lift trucks, added abuse from still more weight concentration. For gondola flooring, increased mechanization means still more load impact and abrasion to go with the deteriorating effects of constant exposure to weather.

N-A-X HIGH-TENSILE steel solves these troublesome problems like none other. Used in Stran-Steel Corporation's famous N-S-F®, nailable steel flooring, N-A-X HIGH-TENSILE builds in extra strength, adds longer life. And top resistance to impact and atmospheric corrosion, plus ready weldability, makes N-A-X HIGH-TENSILE exceptionally suited to the special needs of railroad equipment manufacturers and railroads alike. No wonder sixty-three of the nation's leading railroads have ordered N-S-F for their freight cars.

CHECK THESE IMPORTANT ADVANTAGES FOR YOUR JOB:

N-A-X HIGH-STRENGTH steels—both N-A-X HIGH-TENSILE and N-A-X FINEGRAIN—compared with carbon steel, are 50% stronger • have high fatigue life with great toughness • are cold formed readily into difficult stampings • are stable against aging • have greater resistance to abrasion • are readily welded by any process • offer greater paint adhesion • polish to a high luster at minimum cost.

Although N-A-X FINEGRAIN'S resistance to normal atmospheric corrosion is twice that of carbon steel, N-A-X HIGH-TENSILE is recommended where resistance to extreme atmospheric corrosion is important.

For whatever you make, from steel shop boxes to steel freight cars, with N-A-X HIGH-STRENGTH steels you can design longer life, and/or less weight and economy into your products. Let us show you how.

◀ *Here again* N-A-X HIGH-TENSILE *steel proves its ready weldability. To manufacture Stran-Steel Corporation* N-S-F®, *nailable steel flooring, no less than* eight *separate welds between each two channels are required.*

Tough N-S-F®, *nailable steel flooring of* N-A-X HIGH-TENSILE, *has already won wide acceptance with leading railroads everywhere. So much so, in fact, that more than 50% of all new boxcars now being built are ordered with it.*

This typical modern fork-truck with its giant newsprint roll weighs a whopping 5,500 pounds! N-A-X HIGH-TENSILE *takes even this kind of concentrated abuse easily, lasts for the life of the car.*

N-A-X® HIGH-STRENGTH STEELS

N-A-X Alloy Sales Division, Dept. C-5

GREAT LAKES STEEL CORPORATION

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NATIONAL STEEL CORPORATION

N-A-X Alloy Sales Division, Dept. C-5

Great Lakes Steel Corporation, Detroit 29, Michigan

☐ Please send me 12-page illustrated technical catalog on N-A-X HIGH-STRENGTH steels.

☐ Please have your representative contact me.

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KLIXON Protectors

Standard Equipment on Flint & Walling Motors

"A KLIXON *motor protector is standard specification in all single phase Flint and Walling motors. The owner of an F & W water system is assured of overload protection because his pump is powered by a Flint and Walling motor protected by a built-in* KLIXON *Protector."*

That's how Lauren D. Eckhart, Chief Engineer of Flint and Walling, producers of domestic and farm water supply equipment, sums up his feelings about KLIXON Protectors.

And Flint and Walling is one more progressive manufacturer who counts on KLIXON Protectors to produce maximum motor performance with minimum failures during periods of overload.

You, too, can get maximum overload capacity with dependable over-temperature protection in the motors that operate your equipment . . . just specify and use KLIXON Protected Motors. Write now for complete details on KLIXON Inherent Protection for single and polyphase motors.

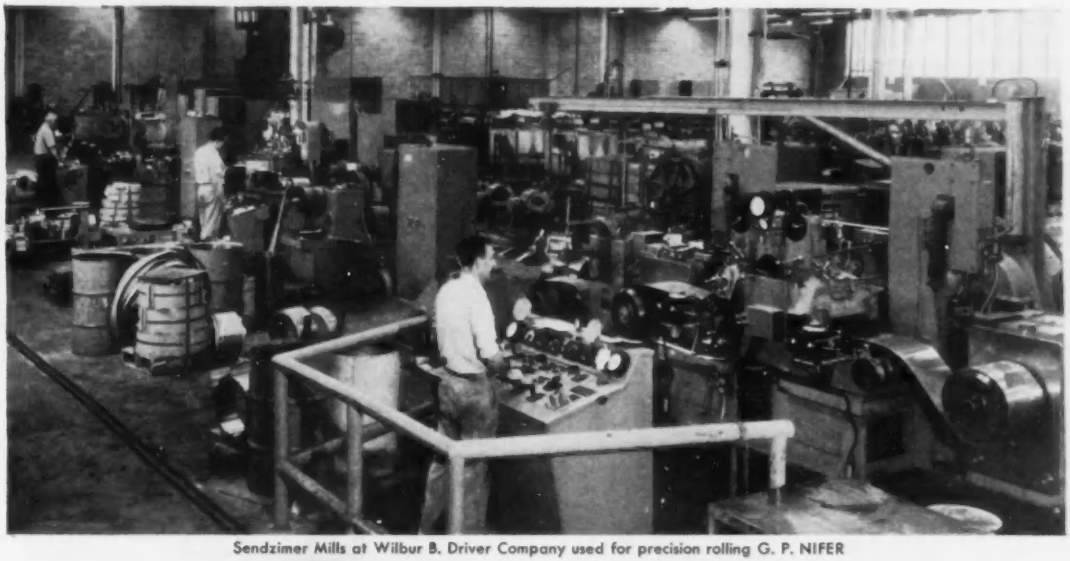
METALS & CONTROLS CORPORATION

Spencer Division 3806 Forest Street, Attleboro, Mass.

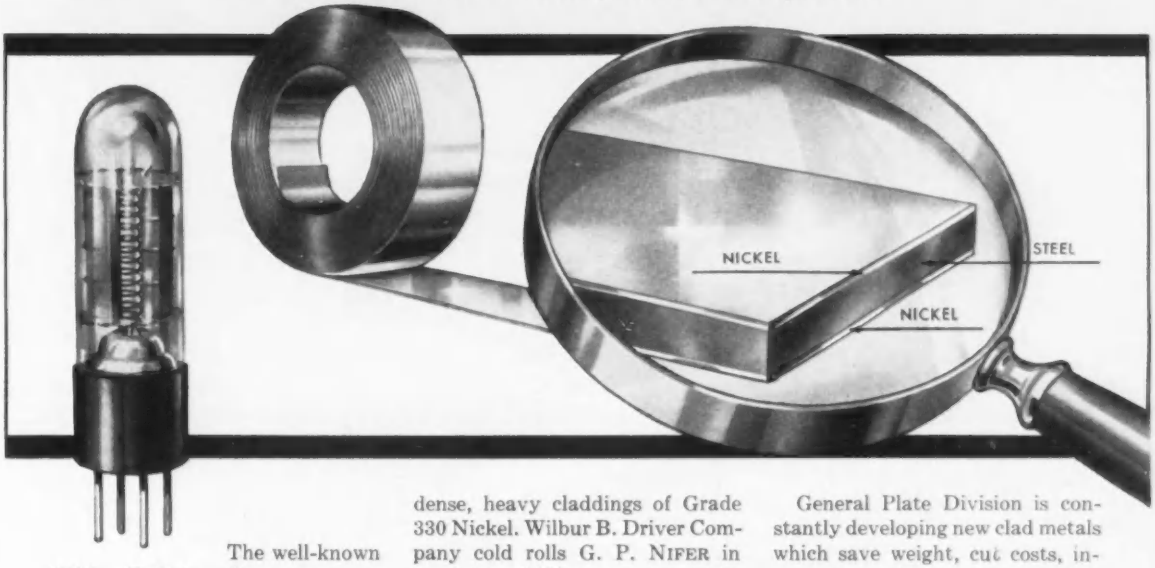
KLIXON

General Plate Nifer®

Helps Wilbur B. Driver Company Provide Customers with Improved Radio Tube Material at Lower Cost



Sendzimer Mills at Wilbur B. Driver Company used for precision rolling G. P. NIFER



The well-known Wilbur B. Driver Company serves the electronic industry by supplying top quality tube materials such as filament and grid alloys, carbonized pure nickel strip and carbonized G. P. NIFER strip.

G. P. NIFER strip is low carbon steel faced on both sides with dense, heavy claddings of Grade 330 Nickel. Wilbur B. Driver Company cold rolls G. P. NIFER in Sendzimer Mills to precise thicknesses for customers who fabricate radio tube parts. And, reports Wilbur B. Driver Company, NIFER not only saves on material cost, but produces better carbonization, resulting in superior radio tube performance.

General Plate Division is constantly developing new clad metals which save weight, cut costs, increase strength, conserve materials in critical supply, improve performance and offer other advantages not found in single metals. Why not write today for catalog GP-1 and get acquainted with the potentials of G.P. Clad Metals in your products?

You can profit by using General Plate Clad Metals.

METALS & CONTROLS CORPORATION

General Plate Division

1006 Forest Street, Attleboro, Mass.

FIELD OFFICES: NEW YORK • CHICAGO • DETROIT • INDIANAPOLIS • MILWAUKEE • PASADENA

HELIARC Welding
breaks the light-gage metal barrier

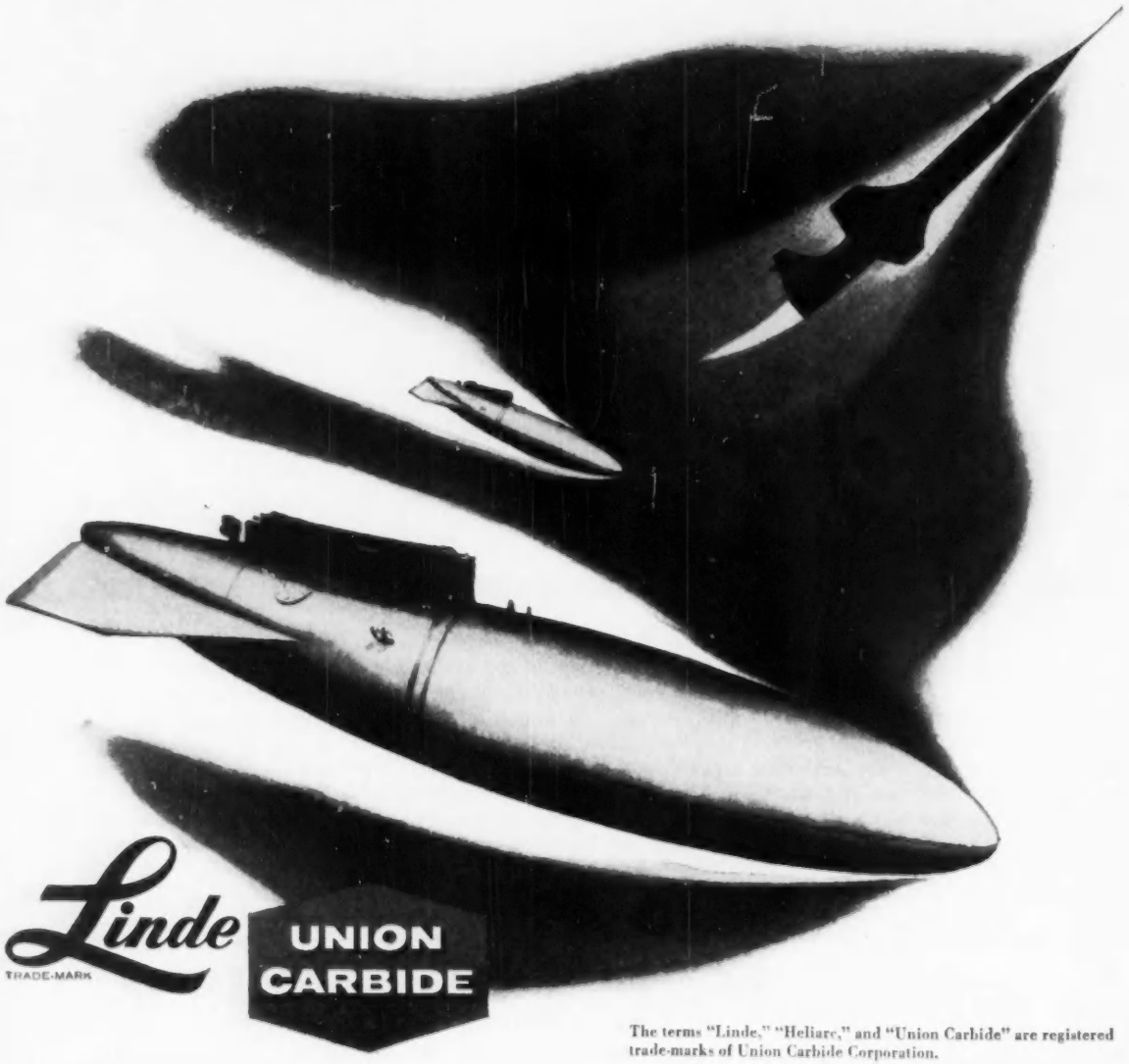
Welding stainless steel sheet into a smooth, streamlined shape for jet plane fuel tanks is a production job for HELIARC Welding. This method, utilizing a tungsten electrode shielded by LINDE Argon, was developed by LINDE especially for use on hard-to-weld commercial metals.

HELIARC Welding can be used either automatically or manually, in all manual welding positions. LINDE Argon in bulk or in cylinders—99.99% pure—protects the weld. Since no flux is required, joints are clean and smooth, without spatter, saving you time and money.

Get more information about HELIARC Welding. For a free copy of the booklet, "Modern Methods of Joining Metals," write Dept. P-64. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

Fuel tanks for jet planes, made of thin stainless steel, are quickly assembled with smooth, clean and sound seams by HELIARC Welding, a LINDE development.

FOR THE BEST IN ELECTRIC WELDING—LOOK TO LINDE!



Linde TRADE-MARK
UNION CARBIDE

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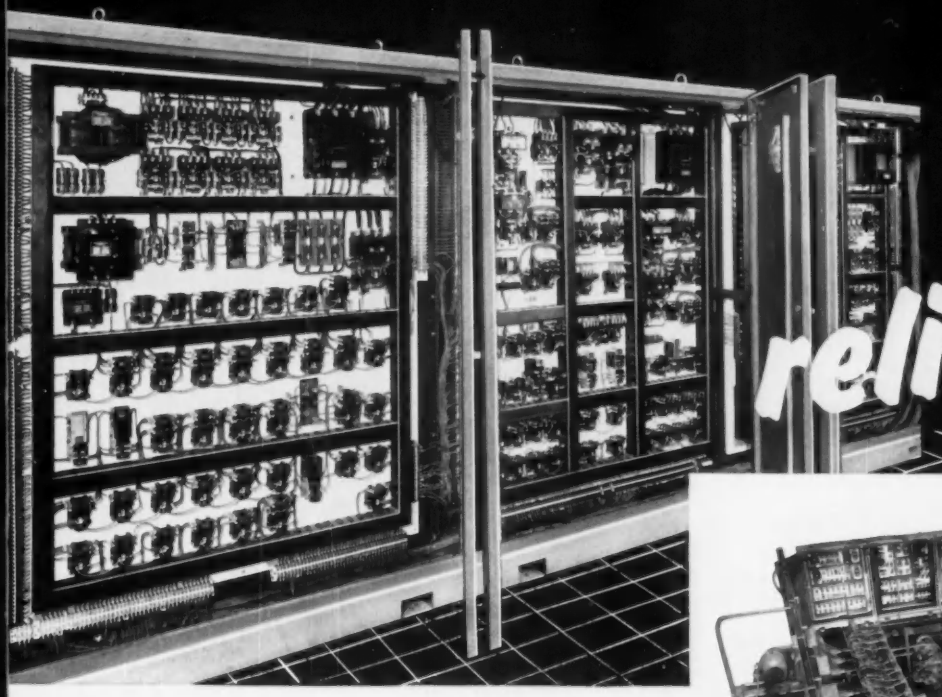
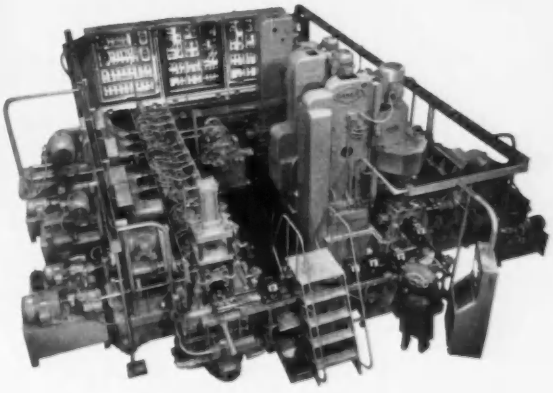


preferred . . . because it is reliable!



This Baker Automatic Transfer Machine is equipped with a special Allen-Bradley control panel, assembled from standard components listed in the latest A-B Handy Catalog.

ALLEN-BRADLEY MOTOR CONTROL

QUALITY

Twenty-six machining operations are performed automatically on this huge transfer machine. To keep this machine operating continuously—to avoid costly production shutdowns—Baker Brothers, Inc., selected Allen-Bradley quality motor control—the simple control that is good for millions of trouble free operations.

The recognized reliability of Allen-Bradley motor starters and relays is the result of their simple design. Having only *one* moving part, wear and consequent trouble are reduced to the minimum. The double break, silver alloy contacts . . . standard throughout the Allen-Bradley line . . . never need attention. They are always in perfect operating condition.

Simplicity of design and silver alloy contacts are features of all Allen-Bradley control auxiliaries—they are similarly trouble free. Therefore, standardize on the Allen-Bradley line of *quality* motor starters, relays, push buttons, limit switches, and other accessories. You cannot possibly make a mistake!

Allen-Bradley Co., 1316 S. Second St., Milwaukee 4, Wis.

In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

BULLETIN 802T
Oiltight
Limit Switch

Has completely sealed operating head and switch body. This adjustable roller lever type saves installation time.

BULLETIN 700
Solenoid Relay

Universal type relay has contacts that can be connected for either "normally open" or "normally closed" operation.

BULLETIN 709
Solenoid
Starter
(Size 1)

Popular across-the-line starter with accurate and reliable overload relays. 8 Sizes to 300 hp, 220 v; 600 hp, 440-550 v.

7-58-R

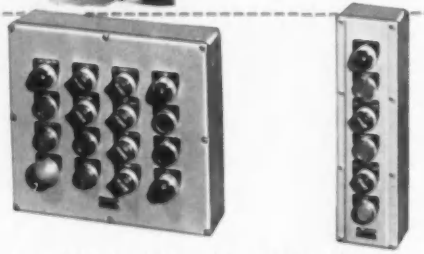
A-B QUALITY

Not only the Motor Starters, but the Accessories must be "Quality," too!

A-B QUALITY

we specify ALLEN-BRADLEY ...all the way

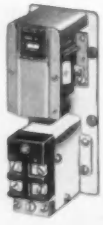
"Trouble" that shows up in a motor starter is often traced to a faulty operating auxiliary—such as a limit switch or even a push button station. Allen-Bradley builds the same high quality into its many accessories as it does into its motor starters—to give you millions of trouble free operations. They are also tested as thoroughly. Contacts are usually double break and always are of a silver alloy, which means they remain in perfect operating condition. It will pay you, too, to specify Allen-Bradley *Quality* control—"all the way!"



Bulletin 800T Oiltight Control Stations. Available in from one to sixteen units, in die cast aluminum enclosures.

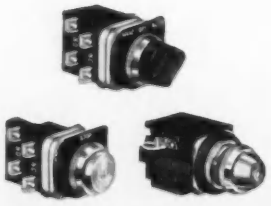
Bulletin 802 Precision Limit Switch, with oil-tight head and body.

Bulletin 805 Foot Switch. In rugged die cast enclosure for the toughest service.



Bulletin 849 Pneumatic Timer. Reliable and accurate.

Bulletin 837 Temperature Control with snap action, precision switch.



Bulletin 800T Oiltight Push Button, Selector Switch, and Press-to-Test Pilot Light.

Bulletin 800 Standard Duty Push Button. One, two, and three buttons; also as selector switch.

Bulletin 836 Pressure Control in NEMA 4 watertight enclosure.

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Allen-Bradley Co.
1316 S. Second St., Milwaukee 4, Wis.
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ALLEN-BRADLEY
QUALITY
MOTOR CONTROL

DEVELOPMENTS

TO WATCH...

Electrically conductive fluids are opening . . .

. . . new routes to design of clutches, brakes, chucks, and such electrical devices as sound transducers, galvanometers, and switches. Several types of fluids are available:

First, there are compounds like nitrobenzene that change from transparent to opaque under the influence of an electrical field, and form the basis of such devices as the "chemical camera shutter" (*PE—Jan. 13, p. 5; and Feb. 10, p. 14*).

Second, there are fluids which change viscosity in an electrical or magnetic field.

In one type, this effect is achieved by incorporating magnetic particles in a suitable vehicle. This is the basis of the "magnetic fluid clutch."

In another type, semiconductive particles suspended in a low-viscosity oil tend to form a viscous, fibrous mass when acted on by an electrical field. In this type, an induced shear resistance on the order of 10 lb/watt can be achieved; and Winslow Electro Fluid Co., Wheat Ridge, Colo., which is working on them, says power consumption is low, and response time is in the range of 100 microsec.

Refractory metal alloys at ¼ present costs . . .

. . . is the claim made by Alscope Explorations, Ltd., Passaic, N. J., for a new continuous-reduction method it is developing. Alscope acquired the basic process from Garden State Metal Corp. about a year ago; says it has now perfected the system to a point ready for licensing. According to Alscope president Nicholas Martini, the process bypasses expensive refining steps by making direct use of refractory metal oxides (titanium, zirconium, vanadium, molybdenum), blending them in an inert atmosphere furnace with such alloying elements as aluminum, magnesium, and copper. The latter are added in powder or ingot form. Furnace temperatures are 2000 to 2500 F. This is below melting point of some of the metals; but apparently the process is designed to take advantage of lower melting eutectics.

Alscope is continuing its research—aiming at applying the process to chromium, columbium, tantalum and tungsten; and at using such elements as iron, nickel, and cobalt as alloying additions.

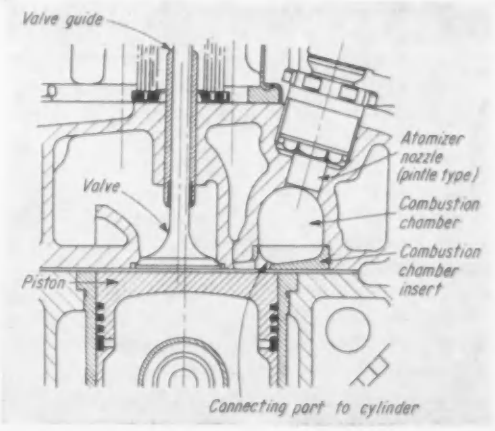
Dome-shape combustion chamber . . .

. . . is key feature of new, smaller size British diesel engine designed for cars, trucks, and industrial applications. A hemispherical cavity machined into the cylinder head forms the top of the combustion chamber, while an inserted machined plug which contains the port forms the lower half of the chamber. As explained by its designer, F. Perkins, Ltd., Peterborough, Northamptonshire, it works this way:

During the greater part of the compression stroke, air is transferred into the chamber from the cylinder, moving upwards through the oval port and producing a swirl in the chamber (transversely across the nozzle). But, just before combustion starts, a final burst of air is injected horizontally, through special passages machined in the head and chamber insert. This increases the turbulence of the air-fuel mixture.

The basic design weighs only 320 lb. On cars, the manufacturer says, it will develop 43 bhp at 4,000 rpm; on lift trucks or pumps, 32 to 35 bhp at 3000 rpm.

Perkins plans to market the engine in the US, has appointed Continental Diesel Corp., 1042 Atlantic Ave., Brooklyn, N. Y. as distributor.



Small British diesel, with its dome-shaped combustion chamber, is diagrammed here. Cylinder bore is 3 in.; stroke, is 3½ in.

DEVELOPMENTS TO WATCH...

Plastic coatings need not pose explosion hazards . . .

. . . if they are properly formulated, says the Naval Research Laboratory. For example, tests of Teflon resins used for lubricating and preserving steel casings show little or no explosion hazard from buildup of electrostatic charges if the resin has a suitable filler. (NRL used chromic acid.) Clear resins may have a dangerously-low conductivity, though, NRL cautions, and should not be used where explosion hazards exist. A report on the study may be obtained from the Office of Technical Services. (PB 131304; 50¢).

Replacement times for major appliances . . .

. . . are defined in a new study, based on actuarial-type life-expectancy tables, made by the Agricultural Research Service.

According to the ARS, families buying new electric refrigerators and electric and gas ranges use them for an average of 15 years. The turnover time on electric washing machines of all types, on the other hand, is much faster—about 9 years.

What about equipment that's bought second-hand? In general, it's kept in service about half as long as equipment that is bought new; though electric ranges seem to be replaced a little sooner than are the gas-operated types (after 6 to 7 years as compared with 8).

The study also showed that rural and urban families differ significantly in replacement policy. Rural families tend to use their electric refrigerators and manual washing machines longer than urban families; while the reverse is true when it comes to gas and electric ranges. The latter is probably explained by the fact that farm families give their stoves longer and harder use than most city families do.

Obsolescence period for military equipment . . .

. . . is considerably shorter than for civilian products (see above); but not quite as short as it may seem.

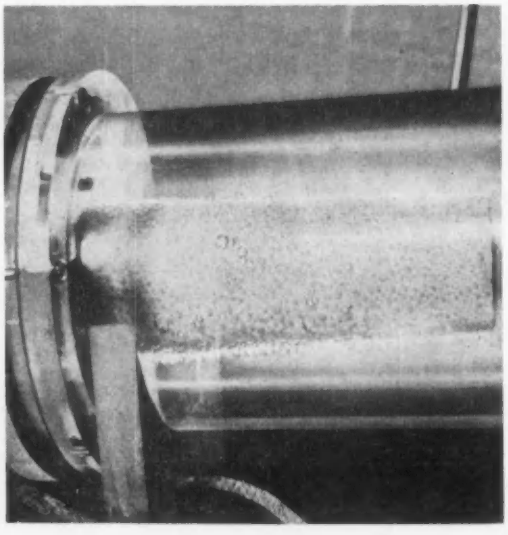
A. G. Waggoner, Executive Assistant to the Director of Guided Missiles, says that, in guided missile programs "we are currently running at an obsolescence rate of 3 to 5 years."

Lead time on guided missiles is being reduced too. Waggoner says the time from design contract award to acceptance test on missiles like the Atlas is now only 2 to 3 years, and proudly points out that the lead time on such big piloted craft as the B47 and B52 was 5 to 7 years.

New engine filtration unit . . .

. . . designed to remove water plus other impurities from fuel, is announced by Permanent Filter Corp., 1800 W. Washington Blvd., Los Angeles, Calif. It's a 3-stage unit, combining 3 different filtration media. First, a synthetic fabric that removes the heavy sludge. Next, a porous ("bonded") bronze filter which takes out particles down to 10 microns and begins to group the smaller water droplets into larger ones. Finally, a glass fiber pad which completes the process "by forcing the water droplets to combine into globules large enough to settle out of the fuel into emptying traps."

The prototype unit was developed specifically for use on jet fuels, but FPC plans to make the filters in capacities from 50 to 1500 gal./min, and foresees applications ranging from diesel truck engines to marine operations. —ARG



Big water droplets form on final stage of fuel filtration unit, then drop out of fuel stream, carrying any remaining impurities.

French Engineers Hope New Regime Sparks Design Boom

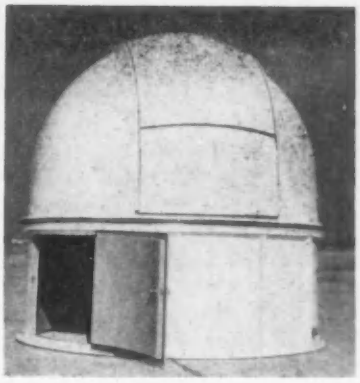
PARIS—Insurrection in Algeria and De Gaulle's return to power had little immediate effect on French engineers and scientists. They went on as before.

Mass demonstrations, all-night sessions of the National Assembly, cordons of gendarmes around government buildings and near martial law did not alter the working day of French engineers, long before inured to the random rise and fall of Fourth-Republic governments. This time, everyone realized, there would be a real change in the government and not a reshuffling of politicians. But during the crisis there was nothing to do but hope for the best and carry on as usual.

Assembly lines kept rolling. A *Product Engineering* survey of major industries revealed that work stoppages were negligible despite strike calls. At Renault's sprawling Billancourt plant on the outskirts of Paris, for example, 95% of the work force reported in on days when mass demonstrations were called by the Communist-led unions.

But De Gaulle's return may have a far-reaching impact on French industry and the lives of the men who design and develop its products. If he can resolve France's most pressing problem—Algeria—De Gaulle as Minister of Defense will be able to spend more of the defense budget on the development of new weapons. Already the new government has allotted $26 million to the aircraft industry, desperately in need of funds to keep its design and development programs going. Even more important, a stable government will at last make possible a coherent economic policy. French industry can then attack with confidence the country's other great problem—selling enough of its products in foreign markets to overcome a staggering foreign-exchange deficit.

Of particular interest to US and French engineers will be the attitude of the De Gaulle government toward participation in the European Common Market—a program certain to be a boon to the product design field.



Styrofoam astrodomes . . .
up to 16 ft. in dia. are being used to house cameras and other test flight recording instruments at missile test ranges in the US and Canada. Prototypes of similar units are being used at earth satellite tracking stations. Previously made of polyester fiberglass, the new domes (above) use Dow Chemical's Styrofoam and are manufactured by Alfred Hofmann & Co., Murphreesboro, Tenn. A wooden frame acting as a mold supports blocks of the 3 in. thick plastic foam which has a 2.2 lb. per cu. ft. density. Applied to the foam blocks is a semi-thixotropic, 100% reactive, solvent free, modified epoxy adhesive, Bondmaster M668 developed by Rubber & Asbestos Corp., Bloomfield, N. J. Glass cloth is then laid up on the blocks to be saturated by the adhesive besides acting as a bonding agent between the individual blocks. A second layer of the adhesive is then applied to the outer surface of the glass cloth. A similar glass cloth is put on the inside of the dome. The domes have been designed to withstand wind velocities up to 150 mph. Such a construction could not be used with polyester resins, because the styrene monomer used in such resins would dissolve the foamed polystyrene.

Working Towards Safer, Cheaper Reactors.

LOS ANGELES—"How safe does a reactor have to be?" is a question that was asked at the recent meeting of the American Nuclear Society here. Scientists will try to answer this when one of the newest reactors goes critical late this year. TREAT (Transient Reactor Test Facility), scheduled for completion at the Argonne National Lab. in Illinois by October, is designed to show what happens when a reactor goes out of control. Energy release rates approaching 800 mw/sec. will melt a sample of uranium fuel at 2000F. High-speed motion picture cameras will record tests through a system of mirrors.

Although the subject is well-known, burnable poisons was a popular topic at the meeting. These poisons are materials with high neutron absorption properties which slow down the fissioning process. When added deliberately to the fuel so that their rate of consumption is equivalent to the rate at which the fuel is used, these poisons are known as burnable poisons. Control rods are still used, however, and for commercial power reactors the conventional control rods have a number of advantages. But in high-performance military or research reactors where a high neutron flux is wanted, burnable poisons make the reactor more self-governing, thus simplifying control, and give a better distribution of flux density. With rods there is a tendency to get cold spots around the rods themselves and hot spots in between.

Another type of "poison" used in the control of reactors consists of injecting boric acid into the water (moderator) of a boiling water reactor. Advantages here are lower capital cost, simpler maintenance, freedom from rod-replacement problems and the elimination of rod hot-spot factors.

Control rods have always posed a problem in reactor design: penetration of the reactor shell; precise location inside the shell; control mechanisms and rod replacement problems.

G. A. Freund, of Argonne Labs says that reactors may be greatly overspecified because designers don't yet know what the safe minimums would be. They hope that planned tests will show how to build more efficient reactors more cheaply.

INDUSTRIAL CHEFS AT WORK:

They Offer Recipes for Top Research Management

HARRIMAN, N. Y.—How should a research department be managed? What training does a research manager need? How does US research administration compare with Russian?

These are a sample of the questions aired by 28 industrial research executives, management specialists and university faculty members at Columbia's 9th Annual Conference on Research and Development, sponsored by the School of Industrial and Management Engineering.

The panel discussions and clinics at Arden House, Columbia's mountaintop campus 40 mi from New York City, produced a variety of views on the ingredients that make for good research administration.

A. M. Lederer, management consultant and president of A. M. Lederer & Co., said R & D is unique in corporate organization because of its short and long-term objectives and its speculative investigations. Principles of management that apply to sales, finance and the like apply to research too, he said, but top management must clearly understand the unique function of R & D and adapt management principles to fit. Thorniest management problem: find a way to evaluate, measure projects under way.

THE TRAINING PROBLEM

Should young scientists and engineers be required to take courses in economics, human relations and other subjects valuable to an industrial administrator? Such courses are required in some engineering schools and generally engineers take them willingly. Scientists, however, shy away.

Some conference participants said students should have industrial management courses to get a forecast of the business world they will have to live with. Others felt that scientists and engineers accustomed to finding order in nature apply the formulas they learn in management courses to industrial situations. They then become confused and disillusioned when individuals fail to behave according to formula. Management courses by this view are most helpful after young engineers work a few years.

Should the manager of a research department have technical training? If he does, it was noted, he automatically gains respect of the people he administers and can educate others in management who do not have technical backgrounds but are involved in technical decisions. A failing of technical managers today, in another view, is that too many are still professional men first and corporation men second.

THE WORLD PICTURE

The international situation has emphasized and highlighted the importance of good research management. Karl Deutsch, Professor of History and Political Science at MIT, held that the US can keep up but never again lead the world in science.

Reasons: Russia's larger population can always spawn more scientists and engineers; the Soviets have a 20-year pool of technical people who've been processed in an educational system that blends Europe's high standards with US quality; they have massive translation facilities; and they give strong motivation to budding scientists.

Drags to US achievement, Deutsch asserted are: industry's shift to market research with emphasis on always being right—a practice containing hidden bias against change, because lobbies do not exist to push infant technologies; the native languages of the best scientists are shifting from German and French to Russian and possibly eventually Chinese—tongues with which we have little national proficiency; finally, American curiosity about foreign discoveries has diminished over the past few decades and resistance to foreign ideas is growing. Scientific nationalism, he said, is increasingly evident in Europe as well.

Science Info Bottleneck World-wide

SAN JOSE, CALIF.—More than 80 prominent scientists, who met at San Jose, for a two-day conference, agreed to a man that adequate scientific communication is sadly lacking, both in the US and abroad.

The gathering was sponsored by IBM Corp., preceding dedication of its $16-million manufacturing plant, education, and research center here.

Information retrieval machines, with big memories and quick access, can be built today if scientists will tell technicians what they want the machines to do, according to Eric De Grolier, chief of exchange of documentation techniques, Milan, Italy.

"Coding is a big problem, but industry and government must be willing to pay whatever money is required to develop a general machine language," he declared.

A possible breakthrough in both information retrieval and dissemination processes was described by H. P. Luhn, senior research engineer, IBM Research Center, Yorktown, N. Y.

Called a "business intelligence system," it can be set up with present-day data-processing machines in combination with communication facilities and input-output equipment. The system and its equipment is expected to be developed to the point of actual use within the not-too-distant future, Luhn said.

Although he did not announce where it would be used, he suggested that government—with the mass of documents it has to process—might be a good place to start. Cost will be variable, depending on the specific size of the operation.

De Grolier believes the US, Britain and France are working in the same general direction toward exchange of scientific information, but that the US has an advantage because it has more money for machines.

On the other hand, European scientists are better informed about what is going on in the US than Americans are about Europe, he said. Europeans can get better abstracts from the US, particularly chemical abstracts from the American Chemical Society.

Another factor is the average American's unfamiliarity with languages, as

One operator does work of four . . .

on hydraulic shear installed at Burrard Dry Dock Co., North Vancouver, B. C. Variable speed, hydraulically-powered back gauges the company says, are set to cut at the desired position. Accuracy is double checked by inching knife down to chalk line before cutting.

compared with the European scientist who may speak three or four languages.

The Russians modeled their scientific information institute after the French center, established in 1939, according to De Grolier.

"But now Russia has 100 times the people and money our institute has," he said. "We have 150,000 references a year, and the Russians have 500,000 long abstracts. We have 300 to 400 abstracters. The Russians have 8000. We have 30 permanent employes. The Russians have 2000."

French computer work is moving ahead in several directions, De Grolier said. Fimorex, a photographic information retrieval system, is in use at CNRS (Centre Nationale De L'Recherche Scientifque) for studies in biology. The Filmorex system also is "more or less" perfected for use by a Navy documentation center, the Institute of Cancer at Villejuif, and the Bellon Pharmaceutical Laboratory at Neuilly.

"England will lag behind the US by two years in making use of information retrieval machines," according to I. J. Good, senior principle scientific officer, Royal Naval Scientific Service, government communications headquarters.

Although there is an IBM 704 in the atomic weapons division at Aldermaston, no Ramacs are in use in England, Good said. There are about 50 full-size computers of other types at work throughout the country.

Problems of censorship, which DeGrolier calls "a disease of our civilization," are about the same in all three countries, the scientists say.

De Grolier listed eight barriers to scientific communication. Six of them are outside the field of science, and two within it:

1. Physical distance between scientists
2. Nationalistic barriers
3. Censorship or secrecy
4. Prejudices against science
5. Ignorance of people about scientific method and language.
6. "Tower of Babel" of languages. This is becoming worse. There is no common language dominant in science today.
7. Specialization. This impedes cross-fertilization of ideas.
8. Bulk of scientific documents and their continuing growth.

WHAT US WANTS

In the US, most scientists would like to see the establishment of some kind of centers for exchange of information, according to G. W. King of IBM's Yorktown Research Center. While some favor a central system, many would like to see several centers established, perhaps by private organizations, and expansion of abstracting services.

Alan T. Waterman, Director, National Science Foundation, believes the problems can best be met in the US by streamlining and strengthening our present system, rather than by centering the problems in one large central agency.

Aim for Largest Scope

VIENNA—Russia is building the world's biggest telescope, with a mirror 240 inches in diameter, according to McGraw-Hill World News.

The USSR Academy of Sciences has set up a special laboratory to assist in building this astronomical instrument, which is a rather complicated project. It will be remembered that construction of the US Palomar Mountain telescope took 10 years.

The new telescope will help scientists penetrate more deeply into the universe. It will also be used for tracking sputniks and rockets which may in the near future be sent to the Moon, Venus and Mars.

Coming Events

JUNE

22-24 . . . . Alloy Casting Institute, Annual Meeting, The Homestead, Hot Springs, Va.

22-27 . . . . American Society for Testing Materials, 61st Annual Meeting, Statler and Sheraton-Plaza Hotels, Boston.

22-27 . . . . American Institute of Electrical Engineers, Summer General Meeting and Air Transportation Conference, Hotel Statler, Buffalo, N. Y.

25-28 . . . . Drop Forging Association, 23rd Annual Meeting, The Homestead, Hot Springs, Va.

26-27 . . . . Society of the Plastics Industry, Midwest Section Conf., French Lick-Sheration Hotel, French Lick, Ind.

JULY

7-12 . . . . National Association of Architectural Metal Manufacturers, 2nd Annual Architectural Metal Institute, Northwestern Univ., downtown campus, Chicago, Ill.

AUGUST

6-8 . . . . American Institute of Electrical Engineers, Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, Hotel Statler, Los Angeles.

13-15 . . . . AIEE, IRE, and NBS, Conference on Electronic Standards and Measurements at Bureau of Standards' Boulder Laboratories, Boulder, Colo.

18-21 . . . . American Society of Mechanical Engineers, American Institute of Chemical Engineers, Joint Heat Transfer Conference, Northwestern Univ., Evanston, Ill.

19-22 . . . . Western Electronic Show and Convention, Pan Pacific Auditorium, Los Angeles.

SEPTEMBER

15-19 . . . . Instrument Society of America, 13th Annual Instrument-Automation Conference and Exhibit, Philadelphia.

23-26 . . . . Association of Iron and Steel Engineers, 1958 Iron and Steel Exposition and Convention, Cleveland Auditorium.

24-25 . . . . Institute of Radio Engineers, 7th Annual Symposium on Industrial Electronics, Rackham Memorial Auditorium, Detroit, Mich.

25-27 . . . . Porcelain Enamel Institute, Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.

28-Oct 2 . . . . Pressed Metal Institute, Annual Meeting, Sea Island, Ga.

Spotlight Hydraulics at M.T. Forum

DETROIT—Dramatic advances in machine tool design are erupting from R & D expenditures of the past two years. This was the concensus of designers participating in the third machine tool production forum sponsored by Vickers here.

Advances include techniques for moving metal rather than removing it, tools that operate at high speeds for machining "exotic" metals and alloys, and application of ultrasonic machining and spark erosion. If present R & D tempo persists, forum participants said, the traditional redesign cycle—7 to 10 years—will be transformed into steady, continuous change. With many machine tools obsolete, the market for new tools looks bright.

The Vickers forum played heavily on present and potential applications of hydraulics to machine tool design. Here are some observations by participants.

AWAIT VANE-TYPE PUMP

Vickers' inexpensive variable-displacement pump for 1000-psi service, first shown at the Chicago Design Show, is expected to debut commercially in 3 months. Designed to solve heat problems in hydraulic systems, the vane-type pump has 1-way rotation and operates at 1800 rpm. Its efficiency rates below its piston counterparts, but is adequate for small volumes that do not use servocontrols.

Slow feed speeds on cutting tools, a recurring problem in machine tool design, can be achieved with large cylinders that easily control relatively large flows of hydraulic fluids. Where small cylinders are essential, present-day valves will handle oil volumes as low as 5 to 10 cu in. per min. To use the fluids most effectively in the control portion of the circuit, design components should be held to a minimum. Flow control valves—now compensated for both pressure and temperature—give consistent performance under diverse conditions and often function better than ratings indicate.

Hydraulic motors are frequently used as an assist or dragload on mechanical drives where torque is not constant. Acumulators on the inlet side of the motor do not appreciably reduce pressure fluctuations or provide steadier torque.

When motors operating heavy indexing tables, decelerate at end of the indexing cycle, they turn into pumps because of table inertia. Sudden pressures capable of cracking the motor head can be avoided by including a relief valve similar to those normally used on a pump.

High-pressure systems (3000 psi and up) cause less trouble than low-pressure systems—because careful engineering and design go into high-pressure systems. However, volumetric expansion of hoses needed in machine tools limits systems in the 5000-psi range.

FIRE-RESISTANT FLUIDS

Water emulsion fire-resistant fluids create noise through cavitation and also substantially reduce life expectancy of pumps, particularly vane pumps. Where piston components are employed, large pistons prolong equipment life.

Fire-resistant fluids now account for 5% of all applications. In the synthetics, water-glycol and petroleum oil emulsions will not effect standard seals. Phosphate esters and chlorinated hydrocarbons require special seals that are now in stock and coded to prevent misuse.

An electro-hydraulic servovalve combined with a rotating hydraulic motor produces highest reliability. Reasons: the servo is very sensitive and occupies an infinite number of positions at either side of neutral; the motor responds rapidly; and the system possesses low elasticity. Small control components of the electric servo can be capsulized to facilitate assembly and maintenance. Disadvantage of the electro-hydraulic valve is lack of ruggedness compared with a pilot valve.

Programming methods for automated machinery exist for both prototype and production work. Prototypes use manually set decade-switches or teletype dials with an operator to set them. Production runs use punched cord and punched tape systems.

For easy maintenance, control boards are best when designed around modular plug-in components with modules made from printed wiring and solid-state components—color coding helps assembly and replacement. Disadvantage of modular construction: electrical connections are established by pressure contacts alone.

Car Drivers Groan—Figures Tell Why

CHICAGO—Many drivers today complain about the cost of owning and operating cars, and the prognosticators cite soaring auto costs as a factor in depressed sales. This isn't just grumbling. For example, statistical calculations by Runzheimer and Co.—a Chicago research engineering firm—trace a steady increase in the cost of driving a basic Chevrolet over the past decade.

In 1946, the Runzheimer statistics show, it cost $973 to drive a 6-cylinder 4-door Chevy sedan 18,000 mi around southeastern New York State. By 1950 the cost rose to $1065, in 1952 to $1198, and in 1956 to $1472. Though costs for the 1958 Chevy have not been calculated yet, company sources say that "operating expenses have risen considerably and the cost of owning and purchasing a car have risen as well."

Runzheimer, which gathers and processes cost figures as a service to clients who pay salesmen mileage for business trips, finds that auto costs vary from one part of the country to another. The Chicago firm has divided the nation into 24 cost areas, and reports that the trend is the same as in New York though the magnitude differs. A decade with the Chevy on the West Coast, for instance, looks like this: 1946, $868; 1950, $1093; 1952, $1248; and 1956, $1436.

On some of the economy or smaller cars, Runzheimer has calculated 1958 operating costs. A Model 113, 2-door Volkswagen sedan driven 18,000 mi around New York will require an outlay of $973 this year—about the same as for the 1950 Chevy. On the West Coast the Volkswagen will cost $870 to operate. Driving an American Motor's Rambler 18,000 mi is put at $1550 in New York and $1412 out west.

These figures include fixed costs—license, insurance and depreciation—as well as variable costs: gasoline, repairs, oil, grease, tires and other maintenance. In the 1946-56 decade, fixed costs for a New York Chevy climbed 160% from $348 to $905 a year. On the Pacific Coast, fixed costs rose more

modestly, from $391 to $797—a 104% gain. Fixed costs on a Rambler in New York this year are calculated at $956 and on the West Coast at $837; on the Volkswagen in New York at $613, and on the West Coast, $511.

Higher initial price for autos, coupled with a relatively quiet second-hand market, has added substantially to annual depreciation charges against cars. Depreciation in this case assumes models will be traded every 30 months, or at 45,000 mi, whichever occurs first. In 1948 the 6-cylinder Chevy retailed for $1546 and lost $591 in market value in the ensuing 30 mo. On an annual basis, that meant $236 for 1948 depreciation. In 1954 Runzheimer figures the Chevy's depreciation at $466 for 18,000 mi of travel and in 1956 at $523. (Part of the 1956 increase includes capitalizing a car radio for the first time. This accounts for $18.)

Variable costs on Chevys chalking up 18,000 mi in the New York area rose 29% in the 1946-56 decade. On a per-mile-basis they swung from 2.45¢ in 1946 to 2.8¢ in 1950, 3.0¢ in 1952 and 3.15¢ in 1956. On the West Coast, variable costs rose 65% in the decade from 2.65¢ per mi in 1946 to 3.55¢ in 1956. This year the per-mi costs of the Rambler is set at 3.3¢ in New York 3.2¢ on the coast. For the Volkswagen it's 2.05¢ in New York and 2.0¢ on the Coast.

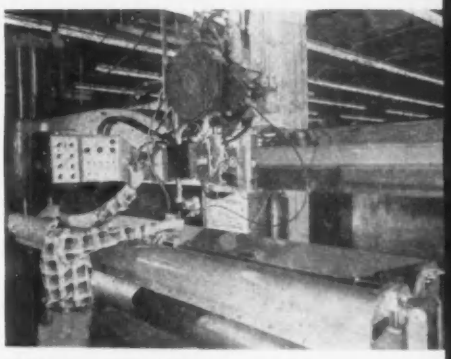
Urge Step-up in US Automatic Factories

DETROIT—By 1970, Russian automation facilities and techniques may be superior to those of the US unless a new emphasis is placed on building automatic factories in this country, said Nevin L. Bean of the automatic transmission division of Ford Motor Co. at the semi-annual meeting of the ASME. He added that, "Although Russian plants are not now as productive, as well organized, well lighted, or as clean as those in this country, many of these adverse conditions are being changed, and very rapidly. The engineering on some of the new automated lines being built would be a credit to any engineering group anywhere."

SOVIET SIGNPOSTS

Mr. Bean said that in his opinion the most important key to future Russian advances is in an organization in Moscow called ENIMS. This is the Experimental Scientific Research Institute for Metal-Cutting Machine Tools. This organization tries to insure that all industries building new units have the latest improvements, including automation. ENIMS controls the types of machines built, their uses and distribution. It is generally concerned with plans for equipment of the future, leaving to factories the design and building of up-to-date machines. ENIMS strives for balanced design and plans tools at least five years in advance. To aid in this, trade journals, especially those from the US, are carefully read and analyzed by a group of experienced Russian technicians.

(Note: E. J. Tangerman, editor of *Product Engineering*, visited ENIMS during his recent trip to Russia. His comments, analysis plus pictures of this scientific organization will appear in the July 14 R & D edition of *Product Engineering*.)



Difficult-to-weld alloys . . .
of titanium, stainless steel, aluminum and magnesium are united by a Weltronic tungsten inert-gas fusion-welder at Boeing Airplane Co., Seattle. As shown here, the 14-ft radial beam of the welding machine has been swung into position over a 10-ft stake fixture prior to laying down a longitudinal weld on a curved surface. Built to Boeing specifications, the machine is fully automatic and capable of a high degree of sequential programming. Arc current, carriage speed and wire feed are controlled electronically within very close limits by the console located behind the radial arm. Vertical position of the welding head, water and gas controls, arc amplitude and wire speed are all pre-set. Either wire or consumable electrodes and helium or argon inert gas are used.

Industry Taking Lease on Life

SAN FRANCISCO—Despite the current dip in capital spending, leasing of capital equipment in the first four months of 1958 shows a 14% gain over the similar period of 1957, according to a report issued by US Leasing Corp. Even R & D facilities are being leased rather than purchased.

Largest users of leased industrial equipment today are 10 manufacturing industries: pulp, paper and allied products; electrical equipment and machinery; chemicals and drugs; rubber products; fabricated metal products; petroleum refining; food products; wood products, aircraft and parts; and printing and publishing.

While the major items leased (aside from automobile fleets) are in the machine tool and metal forming group (lathes, milling, boring machines, hydraulic presses and forges), there has been a decided spurt in leases for mining equipment, construction machinery, pumps, diesel power, cranes, electrical apparatus, communications systems and printing presses.

Water-based manufacturers have taken to leasing tug and barge fleets. Chemical, petroleum and rubber companies are leasing complete contact acid units, cracking plants, research and development plants, and power installations. Lumber companies are leasing whole planing mills.

Major reasons given by manufacturing companies for leasing assets today, according to US Leasing Corp.'s findings, are: (1) tight working capital ratios; (2) preservation of cash for later expansion; and (3) desire to keep liquid capital working in such areas as R & D rather than having it tied up in equipment assets.

NFPA Analyzes Fluid Trend

BEDFORD, PENNA.—Key executives from about 55 fluid-power concerns gathered here for the semi-annual meeting of the National Fluid Power Association and mixed gloom with

optimism as they discussed business and engineering.

The first two days covered general topics, highlighted with talks by government officials and business consultants. DeRose and Associates, Consultants, gave detailed information on how small companies can seek and obtain substantial business from missile and aircraft prime and subcontractors.

In the last day's technical session, Frank Yeaple, associate editor of PRODUCT ENGINEERING, discussed hydraulics and pneumatics in the machine tool industry, giving an analysis of the effect of numerical control on the fluid-power-component manufacturing in dustry. He concluded that although tape control is more readily adaptable to electric and electronic components, fluid-power components can be and are often used. Some of the reasons for selecting hydraulics and pneumatics: dependability, ease of maintenance, lower cost, and concentrated power, depending on the job to be done. Problem still to be licked is feedback: how to convert electrical signals to pressure and movement, then back again to check with the tape. (Note: An article based on this talk will appear in a forthcoming issue.)

Efforts by the NFPA to establish solid identity of its organization in this field are indicated, for example, by the standards it is writing to bring uniformity to symbols for critical cylinder dimensions. Progress on the standards is being slowed by disagreement among the member companies.

Information Machine Announced by Russia

LONDON—Russian scientists are working on a universal information machine which will store technical information and make reference books obsolete, Soviet News reported here.

The machine will store blocks of paper sheets with information recorded on them in code. Logical and linguistic systems still have to be developed, the report says.

Dr. Lev Gutenmacher of the Academy's Electric Modeling Lab., reportedly has built an apparatus which answers eight questions fed into it by a telephone dial device. The answer appears on a television screen in stationary or moving text.

READER TO EDITOR

Understanding Comes First

To the Editor:

Mr. Robert Church (June 2, p. 4) really says something important and hi-minded. "What is our ultimate aim?" he asks. Being only 50% in the junk business, as he calls it, I have been asking myself this question for over 20 years. He suggests self-mastery. This could be true, though I believe it is only a part of what can be realized if one has a more complete understanding of the laws of nature. Such understanding, however, must be based on factual knowledge rather than emotional "knowledge," because the latter is the "junk" that causes the condition he deplores. Thus, our high standard of living has many aspects of what could be called the "hog standard" of living; due to improper people engineering.

Self-mastery, self-understanding, potential self-realization, compatibility in marriage, proper vocation or avocation and the realization of one's assets can best be accomplished if we understand that each person is born very different in mind and body. Precisely how different in every detail is very important for each person to understand. Fortunately, each person has a factual "wiring-diagram" which is based on a revelation of the laws of nature as to his potential of assets and liabilities. These may be cultivated (once understood) for best results, or distorted by emotional "knowledge," as is conventional.

Engineers and scientists could learn much by studying such basic and individual "wiring-diagrams," if interested in ultimate aims. Several are doing just such studying and know what I mean. —WHITNEY E. GREENE
Los Angeles, Calif.

Engineering Unions at RCA

To the Editor:

It is quite obvious that Mr. Sutherland, (May 26, p. 26) and others are not familiar with unions, as organized and controlled by engineers and scientists, or presently affiliated with Mr. Amann's ESA. Every member of these affiliated associations has at least a B.S. degree in the sciences or its equivalent. If Mr. Sutherland were forced to organize a union of engineers he would find its aims, purposes and membership requirements would be the same as those of the "pure" engineer's unions.

Management is always looking for good supervisory personnel. While promoting a good research man is often a bad mistake, here at RCA, Camden area, he can be rewarded by salary increases to a little less than $18,000 per annum. A union official is always under the watchful eye of management, and many of the past officers of the Association of Professional Engineering Personnel at RCA are now part of supervision. —T. W. HECKING
Haddonfield, N. J.

Don't Forget SARAH

To the Editor:

We have noted that considerable interest in air-sea-rescue radio devices has been in evidence in many periodicals. Of particular interest to us has been the statements made with regard to the SARAH success and the intelligent query as to why it is not used in the United States.

Our experience in this area has indicated that air-sea-rescue radio beacons are not universally used in the United States. This is not the case, however, in other parts of the world. Most NATO countries use SARAH beacons for air-sea-rescue purposes; the United States does not. In those few instances that beacons are carried by American planes, no protection is afforded while flying over European, Canadian and other regions because the US equipment is not compatible with SARAH receivers. The converse of this is also true where a SARAH beacon will not activate the American search receivers. —CHARLES URBAN
Administrative Engineer
Simmonds Aerocessories, Inc.
Tarrytown, N. Y.

Correction

In the May 19 issue, p. 12, an error was made in converting the figures to ft/lb of Aluminum Wire and Cable Co., Ltd.'s new anodized material. The values should read: #16 wire, 265 ft/lb; and #36 wire, 18,810 ft/lb.

DOW CORNING CORPORATION

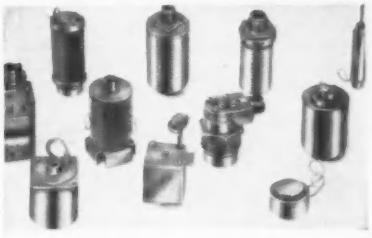
Silicone News

FOR DESIGN ENGINEERS No. 51

SILICONE INSULATION SURVIVES OVEN FIRE

An electrical short circuit recently set the stage for dramatic proof of the exceptional heat stability of silicone insulation. It happened at American Machine and Manufacturing Co., Union, New Jersey. Here's the story:

American Machine produces a wide selection of miniature coils for the aircraft and electronic industries. These coils are insulated with Dow Corning Silicones to save weight and space and to assure their reliability at ambient temperatures in the range of 350 F.



While curing 800 of these units recently, an electrical short circuit caused the oven to catch fire. The oven got so hot that the thermometer *(Cont. Pg. 2)*

SILASTIC-GLASS CLOTH HOSE LASTS AT LEAST 8 TIMES LONGER

Under similar high-temperature conditions, how much longer service life can be expected of a Silastic-glass cloth hose than from a conventional rubber-cotton hose? Answer: at least 8 times longer, according to the developers of this new hose, Hewitt-Robbins of Stamford, Connecticut.

This heat-stable Hewitt - Robbins hose comprises 5 plies of glass cloth sandwiched in Silastic*, the Dow Corning silicone rubber. Both inner-liner and cover are solid Silastic. Burst strength of the hose is estimated at better than 600 psi.

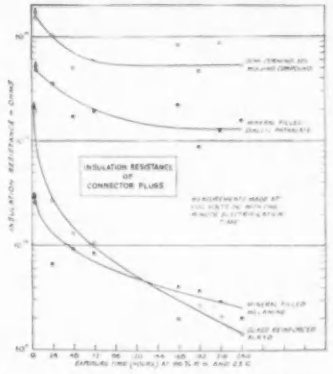
Now in use as radiator couplings for diesel locomotives of Union Pacific, Silastic-glass hoses carry "coolant" as hot as 230 F on the inside, while the outside is exposed to engine compartment heat. They are also subject to constant vibration. Whereas organic rubber-cotton hoses lasted about 3 months in this application, Silastic-glass hoses have already been in service over 24 months and are still in excellent condition. *No. 516*

*T. M. REG. U. S. PAT. OFF.

Even 1000 F Can't Distort Silicone Molding Compound

Three years of research have convinced engineers at Olympic Plastics Company, Inc., Los Angeles, that no other plastic-like material equals silicone molding compound in insulating efficiency or heat stability. Proof is the performance of Olympic's new terminal strip assembly which has been adopted as a National Aircraft Standard.

Molded from a Dow Corning silicone molding compound, this terminal strip shows no sign of heat distorion after 100 hours exposure to 1000 F, a temperature high enough to disintegrate even the best organic plastics.

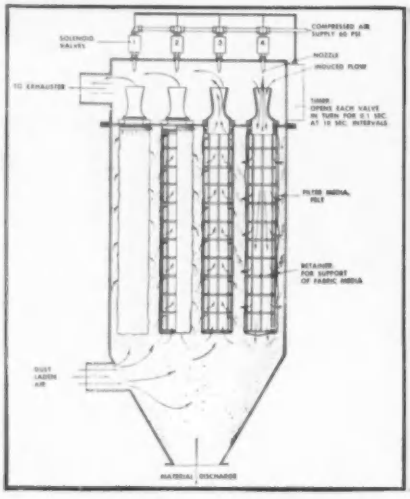


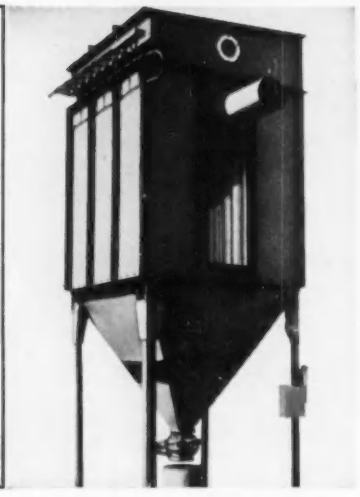
Recommended for continuous duty at 600 F, the Olympic terminal strip completely eliminates arcing at high altitudes —a major weakness of boards made from other materials. That's why it has been adopted by North American *(Cont. Pg. 2)*

FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE NUMBER IN COUPON ON NEXT PAGE MORE

DOW CORNING CORPORATION

Silicone News





A "SLICK" TRICK WITH SILICONES

Plagued with the problem of dust particles plugging wool-felt filters, engineers at Pulverizing Machine Division of Metals Disintegrating Co., Summit, New Jersey, specified Dow Corning 200 Fluid as a release coating. Result: Increased efficiency and service life for their new "Mikro-Pulsaire" dust collector.

Designed to "clean" the atmosphere in plants processing materials such as powdered gypsum, copper, cement and sugar, this unit employs a 1-second reverse jet of air every 10 seconds to keep its wool-felt filters from clogging. Designers have found that a coating of Dow Corning 200 Fluid reduces adhesion of dust to wool-felt fibers. This helps immeasurably to increase the life of filters, and increases the unit's efficiency rating to 99.997% on most materials.

As an additional feature, each filter is gasketed with Silastic*, the heat-stable Dow Corning silicone rubber, to provide a positive seal and make the units operational at temperatures as high as 390 F. Mikro-Pulsaire dust collectors clean 5 to 15 cubic feet of air per minute when the atmosphere is "loaded" with up to 1000 grains of dust per cubic foot. *No. 517*

*T.M. REG. U.S. PAT. OFF.

OVEN FIRE *(Cont.)*

literally burned up after recording 640 F. What's more, all the die-cast aluminum parts of the oven melted before the blaze could be extinguished by the municipal fire department.

To the surprise of inspectors, rigid testing revealed that 797 of the original 800 silicone-insulated coils survived the fire in perfect condition! Heat stability like this makes it possible for silicone-insulated motors, generators and transformers to withstand overloads and ambients that would quickly burn out equipment insulated with other materials. *No. 518*

1000 F TERMINAL STRIP *(Cont.)*

Aviation, Chance-Vought, Northrop, Lockheed and other major aircraft companies.

Using the same silicone molding compound, Olympic Plastics Company manufactures many other types of specialized terminal strips for applications where high temperature resistance and excellent electrical properties are required. *No. 519*

NEW LITERATURE AND TECHNICAL DATA ON SILICONES

Specify Silicone Insulated Motors and Transformers and Save is the subject of a new 8-page brochure that cites the many advantages provided in silicone-insulated equipment. *No. 520*

Silicone Coating for paper and paperboard aids packagers and processors of sticky materials — it keeps gummy and tacky materials from sticking to all types of bags, boxes, innerliners, wrappings and interleaving sheets — it will not migrate nor contaminate goods in contact with it. Send for informative brochure containing sample papers. *No. 521*

To Improve Surface Resistivity of printed circuits and electronic equipment under conditions of high humidity, Dow Corning 991 Varnish has been found to be most effective. *No. 522*

Pressure-sensitive Silicone Tapes — that stick to wet or dry surfaces; form good bonds; have high dielectric strength; repel moisture; are not affected by corrosive chemicals — are described in a folder designed to help you choose the tape best suited to your application. *No. 523*

"Rubber from Rock," a new color-sound movie, explains how Silastic, the Dow Corning silicone rubber, is manufactured from quartzite. Demonstrates why parts fabricated from Silastic retain rubber-like properties from —130 to over 500 F in a wide variety of military and industrial applications. Also covers uses for Silastic as a dielectric in electronic and electrical equipment. To arrange for a showing of "Rubber From Rock" in your plant, circle *No. 524*

1958 Guide to Dow Corning Silicones — consists of 16 pages filled with data and illustrations suggesting ways in which you can cut costs, simplify designs, improve performance and add new sales appeal to your products with Dow Corning Silicones. Cross indexed for handy reference, this all-new Guide includes properties and uses for the silicone products developed in recent months. *No. 525*

Dow Corning Corporation, Dept. 866, Midland, Michigan

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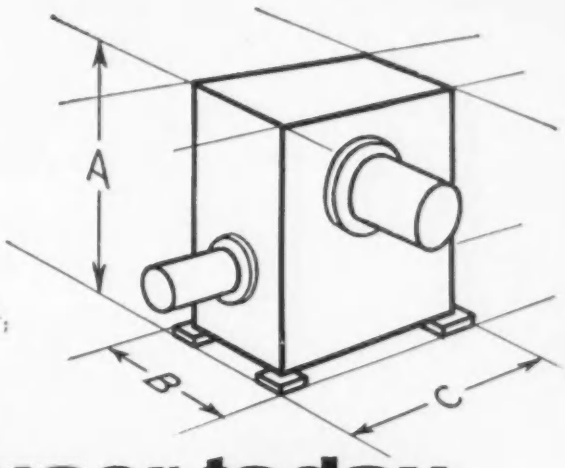
Do-It-Yourself...



Let's design a speed reducer today

So you can't find a speed reducer to fit your latest brainchild without ruining the design? Doggone manufacturers all build reducers too big to fit into those few cubic feet you've got left for the reduction unit back behind the double-ended dingbat?

Revolt! Design your own! Show 'em!

By George, design it yourself and it'll fit. How? Well, you know your size limits. Draw the biggest box that'll fit the space and you've got your reducer housing specifications.

Now you need gears that will (1) transmit the needed horsepower under all operating conditions, (2) provide the ratio your machine requires and (3) fit the space that's available. You'll soon discover that there are limits to what gears can do in transmitting horsepower. The cheapest answer is parallel shaft helical gears. If they'll fit you're in clover. But they take the most room, especially when you're out of the fractional hp range. The right angle worm and gear combination is the most compact drive arrangement.

Here again you have a choice. Cylindrical worm gearing is often used, and if it'll do the job, is worth consideration. But it's not the most compact possibility. The best way to shrink gears and still carry the load is the double-enveloping worm gear design. Both worm and gear are throated and the two literally wrap around each other. This brings center distance of the two shafts closer together and you can put them inside smaller housings.

Does this reduce load capacity? No sir! You can carry the same load with center distances up to 33% smaller than those of cylindrical worm gears. Or use the same center distance and carry a greater load. Will these gears hold up in operation? Sure, if you beef up the teeth, the bearings and the housing. Use straight-sided worm and gear teeth and you'll get all the strength there you'll ever need. Use large taper roller bearings with real B-10 life. Use a reinforced, heavy wall housing that won't distort under load. Put fins on it for added cooling and increased thermal horsepower capacity to meet your needs. Now, put the whole thing together and you've got a speed reducer that's a dilly.

Designing your own speed reducer give you a headache? Looking for an easier way? There is one. Someone's already done exactly what you're talking about. You can order that compact speed reducer right off the shelf. Where?

Cone-Drive Gears, that's where!

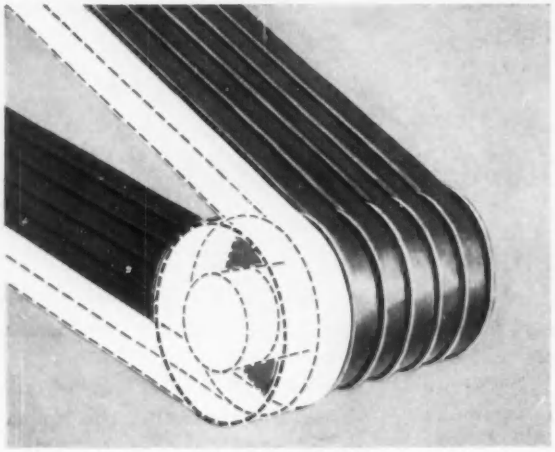
Yes sir. They stock double-enveloping worm gear speed reducers from fractional to 665 hp. Standard ratios from 5:1 to 70:1 in about 15 increments, all interchangeable in any type housing of a given center distance. Worms over and worms under. Gear shafts vertical, too. Single- or double-extended output shafts, or shaft mounted. Over 200,000 combinations possible. Wow! Just about anything you want.

Better get Cone-Drive's new speed reducer catalog that details everything. Ask for Bulletin CD-218. Cone-Drive Gears, Div. Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.

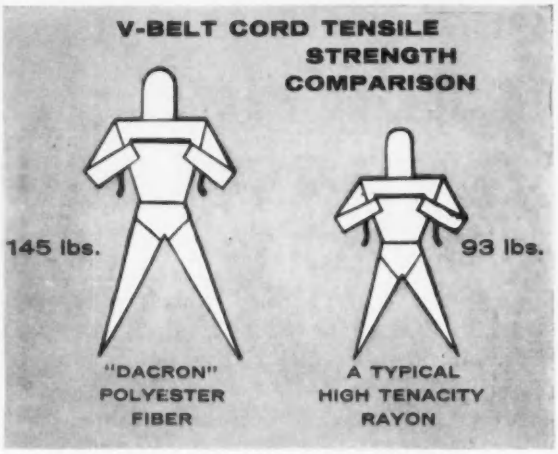
Strong, stable V-belts reinforced with DACRON

REG. U. S. PAT. OFF.

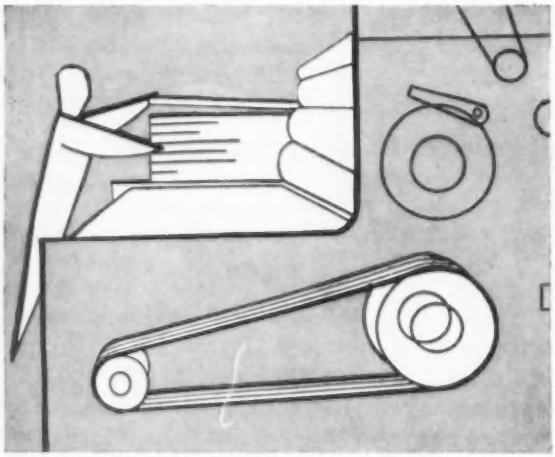
save space... give long-run economy



FEWER BELTS... SMALLER SHEAVES. You achieve greater design freedom with V-belts reinforced with DACRON fiber. Take advantage of their greater strength by using fewer belts and sheaves. Or you can increase drive horsepower capacity without increasing the number or size of sheaves. In a typical installation, 5 belts reinforced with DACRON do the work of 7 conventional V-belts.



IDEAL FOR HIGH-IMPACT OR SHOCK-LOAD DRIVES. V-belts made with DACRON have greater strength and ruggedness to withstand severe shock loads. When compared with tough fibers of a typical high tenacity rayon V-belt cord (Du Pont "Super Cordura"**), DACRON proved 52 lbs. higher in cord tensile strength! That's why V-Belts reinforced with DACRON last longer than ordinary belts.



SAVES VALUABLE MAN-HOURS. Smooth, efficient operation of V-belts reinforced with DACRON keeps production moving at peak capacity. V-belts of DACRON stretch less . . . eliminate the excessive cost of frequent downtime for belt adjustment. Their stability minimizes belt-matching problems, too.

V-belts reinforced with Du Pont DACRON* polyester fiber are stronger than conventional V-belts. Their greater strength means you can use fewer belts, smaller sheaves . . . and narrower drives make it possible to reduce shaft length. DACRON yields slightly under high impact, but resists stretch. Its low moisture regain minimizes matching problems . . . lowers belt inventory.

For the next drive you design or install, consider the advantages of V-belts made with DACRON. Du Pont makes the DACRON fiber used by belt manufacturers in producing their finest-quality V-belts. E. I. du Pont de Nemours & Co. (Inc.), 5518-S Nemours Building, Wilmington 98, Del.

**"Dacron" is Du Pont's registered trademark for its polyester fiber.*
***"Super Cordura" is Du Pont's registered trademark for its high tenacity rayon yarn.*

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DU PONT

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BETTER THINGS FOR BETTER LIVING... *THROUGH CHEMISTRY*

V-BELTS REINFORCED WITH "DACRON" transmit more horsepower...stand greater shock loads . . . give longer flex life . . . give greater opportunities for machine-design improvement

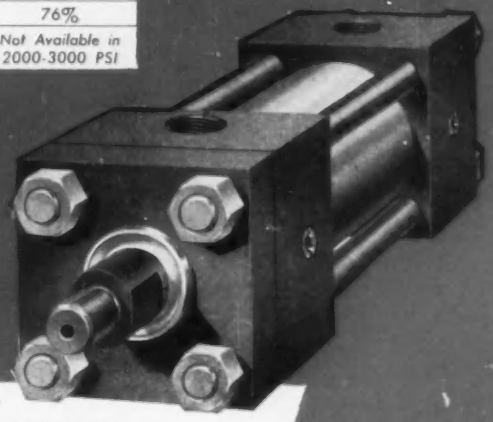
Save 27% or more in cost...

NEW Miller "JOB RATED" HYDRAULIC CYLINDER LINE

JOB RATED, MODEL " J "

BORE	SEVERE OPERATING CONDITIONS	MODERATE OPERATING CONDITIONS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

with IDENTICAL seals, design, and safety factors as the famous Miller "Power-Packed" Model "H" Line for 3000-5000 psi service.



SEAL FAILURE MEANS CYLINDER FAILURE!

1. *No seal made of synthetic rubber is compatible with even 50% of available, commercial, petroleum base hydraulic fluids.*

MILLER Uses All Teflon* Seals to Eliminate External Oil Leakage because Teflon is impervious to all known hydraulic fluids, even fire-resistant types.

TEFLON SHEF SEAL At Tubing Ends

No blind assembly. Is
Shear-proof
Heat-proof
Extrusion-proof
Fluid-proof

TEFLON Seals On Piston Rod And Bushing

Teflon rod flange seal requires no adjustment. Teflon bushing seal is shearproof. Teflon wiper keeps dirt out.

TEFLON Seals On Ball Check And Adjusting Screw

Non-protruding, self-locking, cushion adjusting screw interchangeable with ball check for easy access.

MILLER Uses Resin-Impregnated Leather Piston Cup Seals because they are compatible with petroleum base fluids and some fire-resistant types. Teflon cups available at small extra cost.

2. *Nicked or scored piston rods cause seal failure*

MILLER Uses Case-Hardened Chrome-Plated Piston Rods because they prevent nicks, scoring and rust.

Write for new bulletin giving complete details plus valuable data on column strength, cylinder forces, pipe sizes, safety factors, acceleration, air-oil devices, and other useful information.

NOW! . . . You can save MORE with quality Miller "Job-Rated" Cylinders than with cut-price, lesser quality hydraulic cylinders. And the "Job-Rated" Cylinders are also available under the same immediate shipment program as the Power-Packed Line (2 hours if necessary—3 days normal).

*du Pont trademark for tetrafluoroethylene resin which withstands temperatures from −100° F. to +500° F. and all hydraulic fluids.

OTHER MILLER QUALITY FEATURES

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- Interchangeable, Space-Saving Square, 4-Tie-Rod Design
- Precision Honed Barrels

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DIVISION OF FLUCK-REEDY CORPORATION
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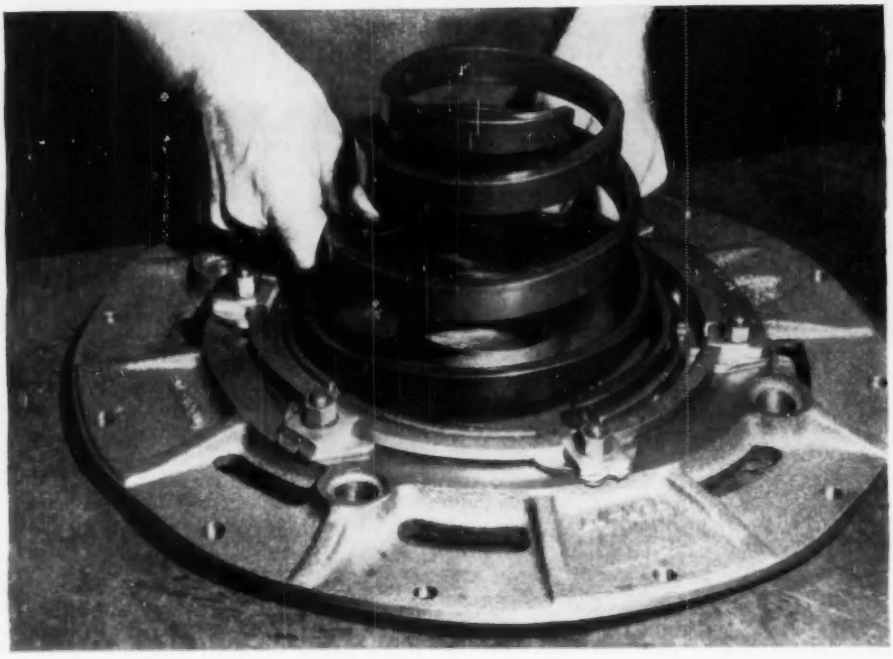
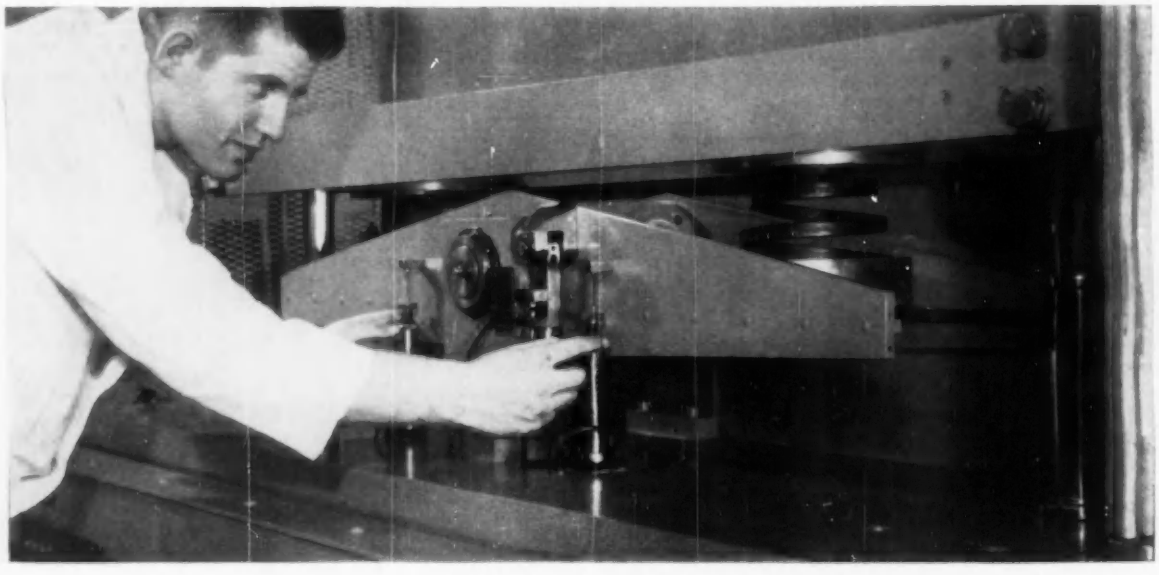
AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS



USS American Springs give longer life,



In the **AS&W** Spring Laboratory a semi-resonant spring fatigue machine is testing the Lipe-Rollway clutch spring. At speeds of 700 cpm this spring is functioned beyond its normal life span and at higher than normal stresses to prove conclusively its superior design as a clutch spring.

A USS American flat wire compression spring is shown in place in the Lipe-Rollway clutch. Four round wire compression springs are also being installed in the clutch.

better performance in heavy-duty clutches

. . . thanks to AS&W Spring Engineering Research Service

The Lipe-Rollway Clutch Division, Lipe-Rollway Corporation, Syracuse, N. Y., manufactures automotive clutches for heavy-duty trucks, tractors, buses and other large mobile equipment. Because USS American Springs play a vital part in the performance of these clutches, Lipe-Rollway asked the AS&W Spring Engineering Research Service to test the springs and determine if any changes should be made in the design to improve and maintain the high performance standards.

As a result of these tests the AS&W Engineers recommended certain important changes to give the springs longer life. After this recommendation was adopted by Lipe-Rollway, Mr. Harvey Gray, Chief Inspector & Quality Control, had this to say: "Exceptional service has been realized from our American Steel & Wire Springs."

If you have a spring problem or would like advice on the use of springs in your product, get in touch with our general office in Cleveland, or any American Steel & Wire Sales Office. You can benefit from the knowledge of AS&W's Spring Engineering Research Service. The Service has been engaged in laboratory experiments of static and dynamic testing for 20 years and has accumulated invaluable data on stress and fatigue life of steel springs, while endeavoring to improve efficiency in the use of steels—from steel chemistry through product application—to more economically cope with today's rigorous demands. This accumulated knowledge of the AS&W Spring Engineering Research Service is at your disposal.

American Steel & Wire Division, General Offices: Rockefeller Bldg., Cleveland 13, Ohio. *USS and American are trademarks*

American Steel & Wire Division of USS **United States Steel**

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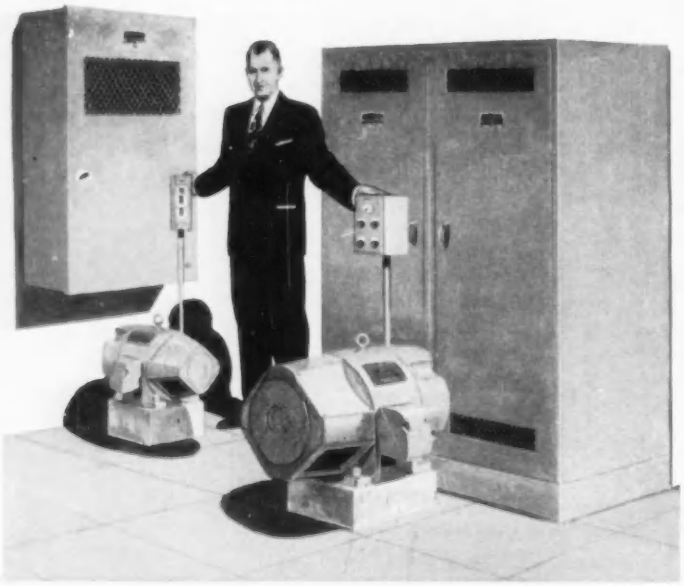
Cutler-Hammer presents ULTRAFLEX the spectacular STATIC POWER Adjustable Speed Packaged Drives

NO MOVING PARTS!

Cutler-Hammer Ultraflex Packaged Drives provide outstanding savings in installation, operation, and maintenance



ULTRAFLEX • *E* 25 hp ULTRAFLEX • *M* 100 hp

CUTLER-HAMMER CONTROL C-H

Ultraflex Packaged Drives offer new opportunities for quick, cost-cutting installations. Light, compact static power conversion components have replaced the conventional m-g set resulting in substantial savings in size and weight. Ultraflex Packaged Drives save up to 50% in valuable floor area . . . up to 75% in weight. Ultraflex units require no balancing or alignment attention during installation.

Ultraflex Packaged Drives provide a new high standard of operational efficiency, ultra-responsive speed control, ultra-precise speed regulation. Exclusive Ultraflex static power conversion systems guarantee greater efficiency than ever possible with conventional drives. Every Ultraflex Packaged Drive works perfectly without forced ventilation which means less power is consumed as unwanted heat. Also, Ultraflex Packaged Drives are noise and vibration free.

Dependable, maintenance-free performance is one of the most outstanding achievements of the all new Cutler-Hammer Ultraflex Packaged Drives. With Ultraflex Static Power Conversion Systems there are no bearings to lubricate. There are no commutators to service, no brushes to replace. There are no shafts to align, no couplings to maintain, no inertia loads to balance. There are no ventilation fans, no filters to clean or change.

Cutler-Hammer Ultraflex Packaged Drives are available in two forms . . . Ultraflex E—the 1 to 40 hp, low cost electronic type adjustable speed drive and Ultraflex M—the 1 to 200 hp, ultra-efficient magnetic amplifier type adjustable speed drive. Both forms come complete with the Ultraflex control unit, heavy-duty D-c drive motor and operator's control station. For detailed information, write today on your company letterhead for new descriptive bulletins EN64- Ultraflex E and EN65- Ultraflex M.

CUTLER-HAMMER Inc. 1332 St. Paul Ave., Milwaukee 1, Wisconsin.

FLEXIBLE CONNECTORS, in a variety of sizes, constructions, materials, are designed to meet many working conditions. Our sales representatives in cooperation with our engineering design service will be glad to be of assistance.

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Large-diameter flexible metal connectors in stainless steel and other alloys—to handle expansion and contraction, wide range of temperatures, corrosive fluids, high pressures, and vibration.

Jet engines, modern chemical plants, rockets, atomic energy plants have created a new technology that calls for new products. The American Metal Hose Division of The American Brass Company is constantly working with design engineers on special flexible connector assemblies to meet new problems.

Equipped to work in stainless steel, Monel, and aluminum as well as in other alloy steels and copper alloys, these Anaconda specialists welcome the opportunity to help you get the flexible metal hose you need to meet your problems of expansion and contraction, movement, vibration, corrosion, pressures, and temperatures.

FREE TECHNICAL SERVICE. For engineering assistance on special products—or for a free copy of our General Catalog showing the full line of standard American Flexible Hose and Tubing products—write: The American Metal Hose Division, The American Brass Company, Waterbury 20, Connecticut.

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FLEXIBLE METAL HOSE AND TUBING
an
ANACONDA®
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Please send me your free, 60-page General Catalog containing basic information on all types of metal hose and tubing, fittings, etc.

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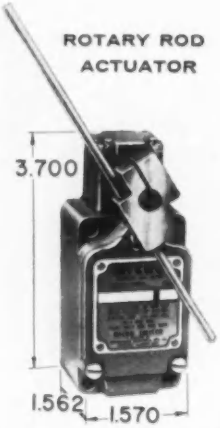
MICRO SWITCH Precision

...FIRST IN PRECISION SWITCHING

Two sound ways to

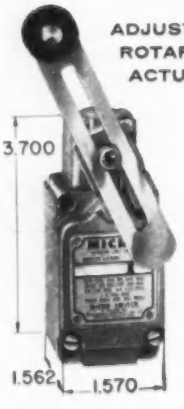
Compact "LS" Limit Switches are Available in 6 Different Actuator Designs



ROTARY ARM ACTUATOR

ROLLER PLUNGER ACTUATOR

PLUNGER (IN-LINE) ACTUATOR



These are small two-circuit, completely sealed limit switches. Their small size and versatility of mounting permits compact installation on all types of industrial machinery which require dependable long-life precision switch gear.

In this "LS" series there are six actuator designs. All rotary actuators are field adjustable to operate in clockwise direction, counter-clockwise, and in both directions—with operation point adjustable to any position thru 360 degrees. Their heads can be faced in any of four positions.

The ½"-N.P.T. internally tapped conduit opening is in the bottom of the housing. The replaceable basic switching unit within enclosure has No. 8 terminal screws.

COIL-SPRING ACTUATOR

Can be operated from any direction. Useful in foundry, conveyor and packaging operations.

ROTARY ROD ACTUATOR

Has extremely low force characteristics. Rod is adjustable to any length. Operating point and direction are adjustable. Excellent for use in counting and detecting applications.

ROTARY ARM ACTUATOR

The heavy duty forged aluminum arm actuator with roller is designed for cam and slide operation. Field adjustable operating point and direction. Its uses are unlimited.

ROLLER PLUNGER ACTUATOR

For slow-rise cams or slides, this actuator head can be rotated 90° for operation by cams whose approach is perpendicular to the mounting surface of the switch.

PLUNGER (IN-LINE) ACTUATOR

For use where the switch can be located so that the switch plunger motion is in line with the actuating device. Plunger has ¼ inch overtravel.

ADJUSTABLE ROTARY ACTUATOR

Roller lever arm length is adjustable to any point in a 2½ inch range. Head assembly can be positioned to any of 4 sides of switch. Actuating direction and operating point are adjustable.

For details as to electrical ratings, mechanical characteristics, adjustability, and other features on this series of limit switches, ask for Data Sheet 138 and Catalog 83 on enclosed switches.

Switches have uses unlimited

improve initial design

The New "E6" and "V6"... Easier Installation
... Better Sealing ... Improved Insulation

The new "E6" and "V6" series of small limit switches have many new and improved features over the design first introduced by MICRO SWITCH in 1939. This design is the smallest and most compact enclosed limit switch available for all industrial uses. This new series is interchangeable with the old series—same mounting holes, and same envelope (housing) dimensions.

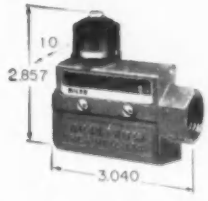
The new housing is divided into two parts with the terminal screws exposed. This saves wiring time.

The new one-piece elastomer combination insulator and seal is cemented into the bottom half of the switch assembly, replacing a separate gasket and wrap-around glass cloth insulator. This saves installation time and provides excellent insulation and sealing of the enclosure when assembled.

The new housings have heavier walls yet envelope (housing) dimensions are the same as the old design. Hexagonal conduit hub facilitates connecting of conduit.

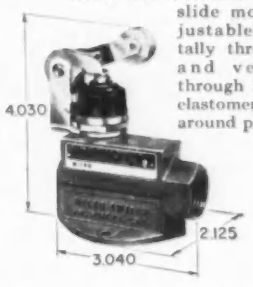
Six different actuator types are available. All six are available in either side mounting (E6) or bottom mounting (V6) designs.

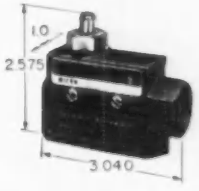
Ask for Data Sheet 145 and Catalog 83 for data on line of enclosed switches.



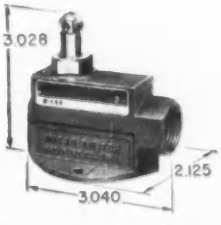
Actuator for straight, in-line operating motion with controlled overtravel. Elastomer seal boot around actuator protects against dirt and moisture.

Roller lever actuator for cam or slide motion, adjustable horizontally through 360° and vertically through 225°. Has elastomer seal boot around plunger.

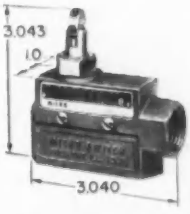




Plunger actuator for straight, in-line operating motion with controlled overtravel.



Roller plunger actuator for slow-rise cam or slide motion with controlled overtravel. Roller in line with case.



Roller plunger actuator for cam or slide motion with controlled overtravel. Roller at 90° angle to case.

Roller lever actuator for cam or slide motion, adjustable horizontally through 360° and vertically through 225°.

MICRO SWITCH . . . Freeport, Illinois
A Division of Honeywell

The two-word name MICRO SWITCH is NOT a generic term. It is the name of a division of Honeywell.

Honeywell
MICRO SWITCH PRECISION SWITCHES

AUTOMATIC WASHER SPINDLE

Is equipped with two Torrington Drawn Cup Roller Bearings for operating stability and long pregreased life. Spindle thrust is handled by one compact Torrington Needle Thrust Bearing.

New Low-Cost Bearing Advances Design and Performance of Home Appliances!

The new Torrington Drawn Cup Roller Bearing opens new possibilities for improved design and performance of washing machines and other major appliances.

For the first time, the advantages of drawn cup outer race construction are available in a precision, compact and low-cost roller bearing. This construction permits exceptional compactness, simple housing design and easy installation by press fit. Highly efficient roller guidance and ample provision for lubricant storage insure smooth starting, cool running and extended service life, especially where high-speed operation and long pregreased life are required.

Today's designer now can secure the advantages of efficient anti-friction performance at low cost in an exceptionally lightweight, compact design with the new Torrington Drawn Cup Roller Bearing. For engineering assistance, call on your Torrington representative. And write for the new bulletin, "Torrington Drawn Cup Roller Bearings." **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**

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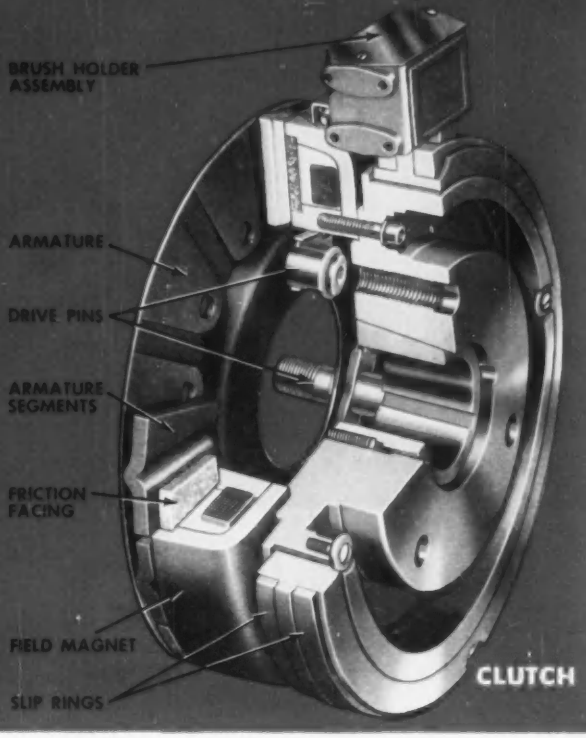
The New EATON Dyna-torQ

MAGNETIC-FRICTION CLUTCHES, BRAKES, CLUTCH-BRAKES, CLUTCH-COUPLINGS

Are the Accurate, Trouble-Free Means of Controlling Power and Motion in Modern Stop-and-Go Machines

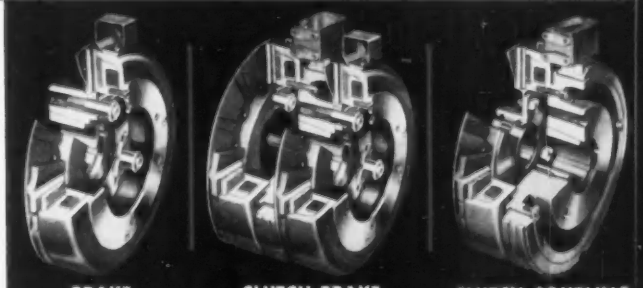


The Eaton Dyna-torQ electro-magnetic friction units include a number of unique design advancements which provide longer life and superior performance with less maintenance. Check the following important advantages:

1. **Extremely Rapid Response in Clutching and Braking**—makes Dyna-torQ units ideally suited to a wide range of manual and automatic cycling applications.
2. **Smooth, Shockless Engagement**—permits rapid operation without backlash or chatter.
3. **Highly Effective Cooling**—maintains lower operating temperatures; permits fast, repetitive actuation.
4. **Self-Adjustment**—automatically maintains proper clearance between armature shoes and field magnet.
5. **Simple, Accurate Control**—manual or automatic; may be had to operate on 110, 220, or 440 volt, 60 cycle, alternating current.
6. **Low Maintenance Costs**—result from unique design features and superior quality of construction, assuring long operating life and minimum down-time.

Eaton Dyna-torQ Clutches and Brakes are electrically operated, disc-type friction units having two basic components: a field magnet and an armature. Torque is transmitted as the magnet pulls the armature into engagement. Because the pull of the magnet is direct without intricate linkage, and the movement of the armature is slight, Dyna-torQ units are capable of extremely rapid response in clutching or braking.

Ask us to tell you how these Dyna-torQ units will fit your equipment.



WIDE RANGE OF SIZES AND CAPACITIES

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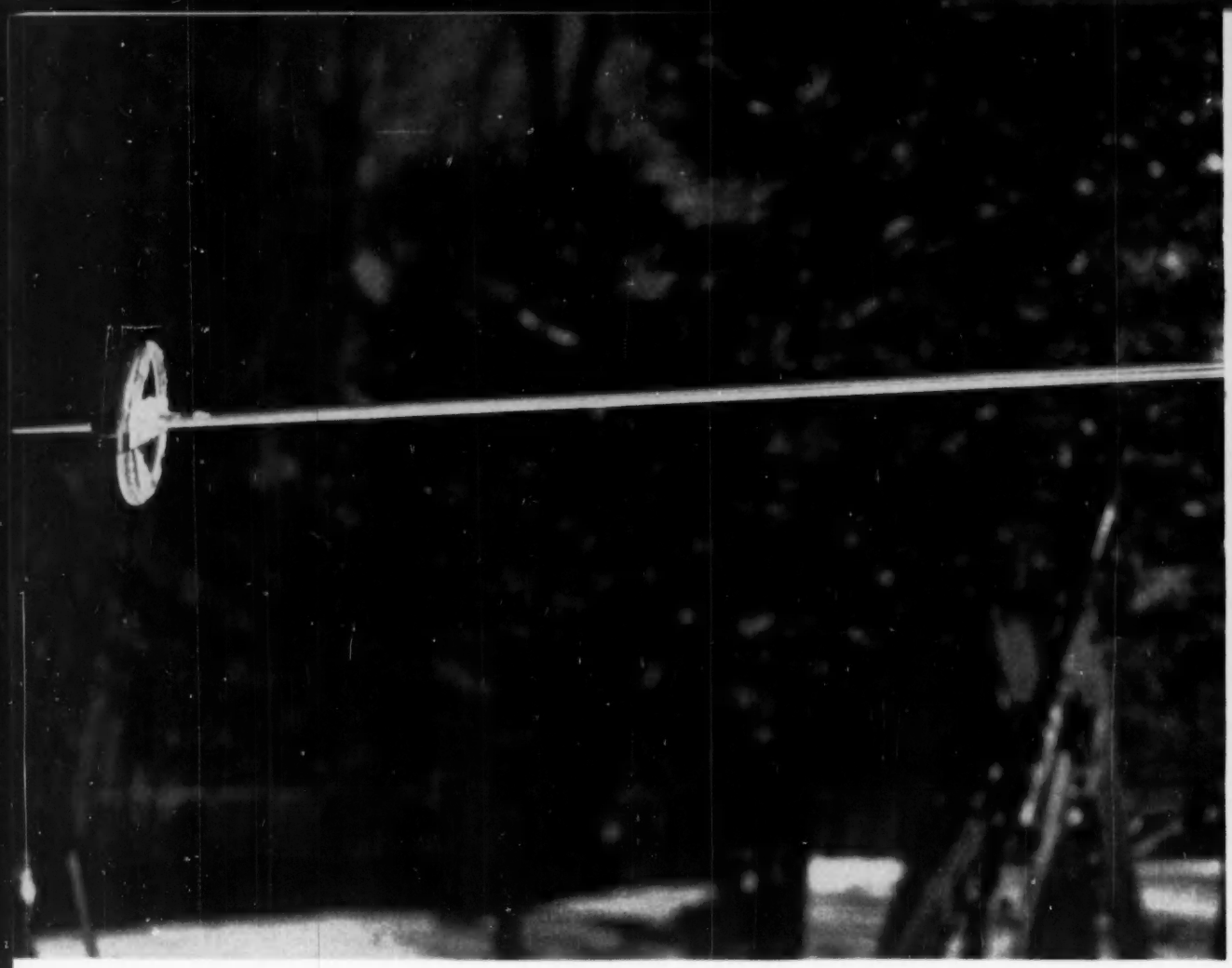

Lightness—There are a few products in this world that you don't want to be light—like pile drivers, dumbbells and paper weights. But generally speaking, every designer strives for the lightest product that will do the job, especially in things like truck trailers and off-highway earthmoving equipment (the lighter the unit, the greater the load capacity) and in structures like a bridge, which has to support itself *and* a roadbed.

Lightness is easy to attain. For instance, you could make a ski pole out of balsa wood, rather than the Stainless shown above, and never know you were holding it. But almost always as we strive for lightness, we also demand a certain amount of stiffness, ductility, strength. More than that, we need a material that can be fabricated on high-speed machinery.

So it's interesting to note that today, in cases where lightness is absolutely vital and *hang the cost*, designers still turn to steel rather than costlier materials when they need low weight and high performance.

When our Explorer I satellite screamed into outer space, it was cased in Stainless Steel. On every high-performance aircraft, the landing gear is made from ultra-strong steel because each single pound shaved from the landing gear assembly saves from 7 to 10 pounds of total aircraft weight, since it reduces the wing area, thrust and fuel required for the specified performance. Today, as we prepare for the first exospheric manned flight, we are completely sheathing the fuselage in steel, because no other available material has a better combination of lightness and high temperature strength.

In new, light-weight bridges, designers automatically think in terms of the new alloy and high strength steels. They're so strong that thinner, lighter sections can be used, and they have the extra atmospheric corrosion resistance necessary.

The new steels should be chosen and fabricated with care, and the final selection should be made by a skilled metallurgist—either on your staff or ours. United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

United States Steel Corporation • American Steel & Wire • Columbia-Geneva Steel • National Tube
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USS United States Steel

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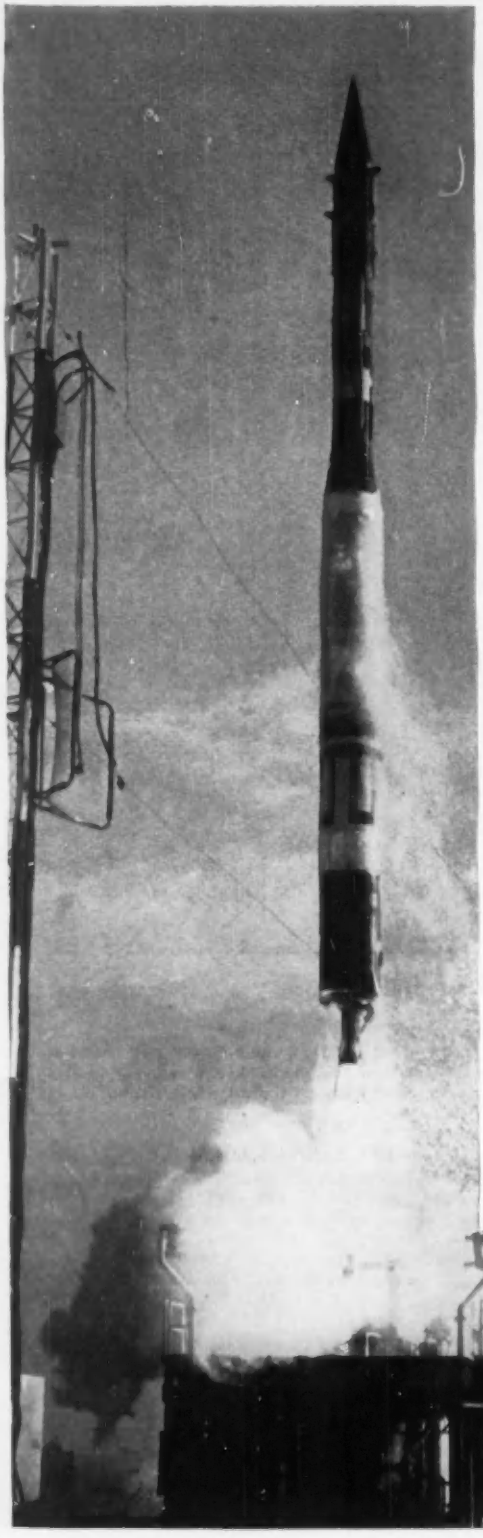
STEELS FOR DESIGN

Lower Left—Problem: Design a trailer to haul more coal and stay within the legal highway weight limit. Solution: Marion Metal Products Company used USS COR-TEN High-Strength Low-Alloy Steel to build a bigger trailer that is lighter because the stronger steel can be used in thinner sections. Payoff: The new units weigh 23% less than the old, have a 50% greater payload, and gross weight is *still* within the legal limit.

Lower Middle—Problem: Build a 40-ton-capacity bottom dump trailer that would have the highest payload-to-weight ratio ever obtained. Solution: Athey Products Corporation designed the unit with USS "T-1" Constructional Alloy Steel which combines a minimum yield strength of 100,000 psi with weldability and remarkable toughness. Payoff: New trailer weighs 11,000 pounds less than conventional construction and hauls payload over 3½ times its own weight.

Lower Right—Problem: Replace 550-bbl. fermentation tanks with new tanks of same capacity but light enough to hang from the ceiling. Solution: Chicago Steel Tank chose Type 304 Stainless Steel and a unique new design utilizing Stainless Steel's strength and formability. Payoff: New tanks weigh only one-fourth as much as the old and have identical capacity.

USS, COR-TEN and "T-1" are registered trademarks



B.F.Goodrich

B.F.Goodrich Rivnuts® guard control cables on Vanguard rocket

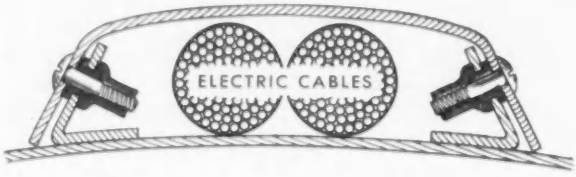
They couldn't put the electrical control cables *inside* the second stage of the Martin Vanguard rocket because of the integral fuel tanks. So they ran the cables *outside*—and protected them with a special cover.

To fasten this cover to the rocket, project engineers chose B.F.Goodrich Rivnuts—for two reasons.

First, B. F. Goodrich Rivnuts provide a vibration-resistant nutplate that won't jar loose in flight. The cover always stays solidly in place. Second, with Rivnuts the cover can be removed and replaced as many times as necessary during pre-flight preparations.

B. F. Goodrich Rivnuts, the only one-piece blind fasteners with threads, can be installed by one person—from one side of the work—in seconds. Upsetting is easy. Just thread the Rivnut on the header tool, insert in the work, and upset. In every kind of operation Rivnuts are used to speed assembly—simplify fastening jobs in thin sheet metal, plastic, rubber and wood.

Find out how B. F. Goodrich Rivnuts can solve fastening problems in your orbit. Send for the free Rivnut Demonstrator that shows—with motion—how Rivnuts can be used to fasten *to* and *with*. Write: B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Dept. PE-68, Akron, Ohio.



B.F.Goodrich aviation products

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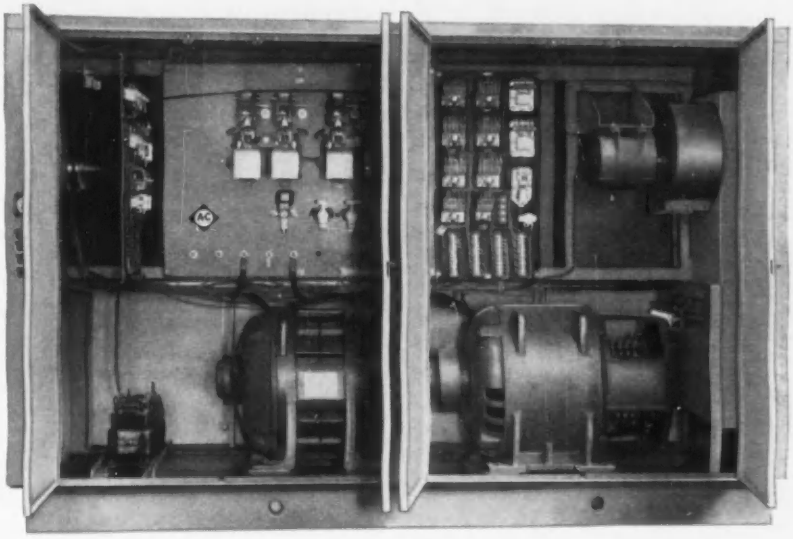
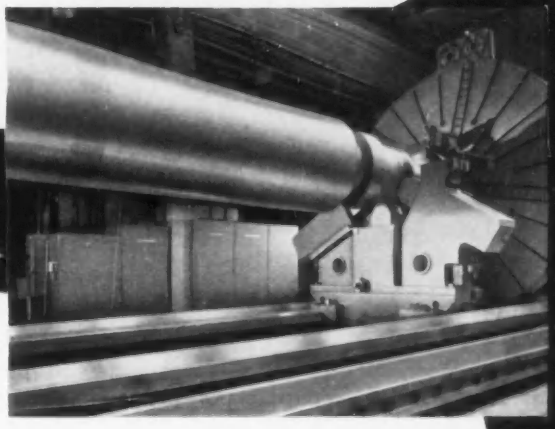
long-run power by Allis-Chalmers



Size 5 *Ultra-Speed* power unit, rated 125 hp, providing reversing and regenerative braking.

This 14-foot lathe uses constant speed and quick stops, starts and reversals.



New dependability in power conversion

Ultra-Speed — remember it! It's a name you'll be hearing more of in machine tool applications. It identifies Allis-Chalmers variable-speed package drive — the complete power conversion unit featuring wide speed range and continuity of operation.

Here, in a compact, filtered air cabinet, is all the equipment necessary for on-the-spot conversion. Components are precisely integrated. M-g sets are selected for exact horsepower requirements; magnetic amplifiers are provided for smooth, selective speed control.

Look to *Ultra-Speed* package drives for savings in maintenance and installation, and for longer tool life. Call your nearby A-C office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wis.

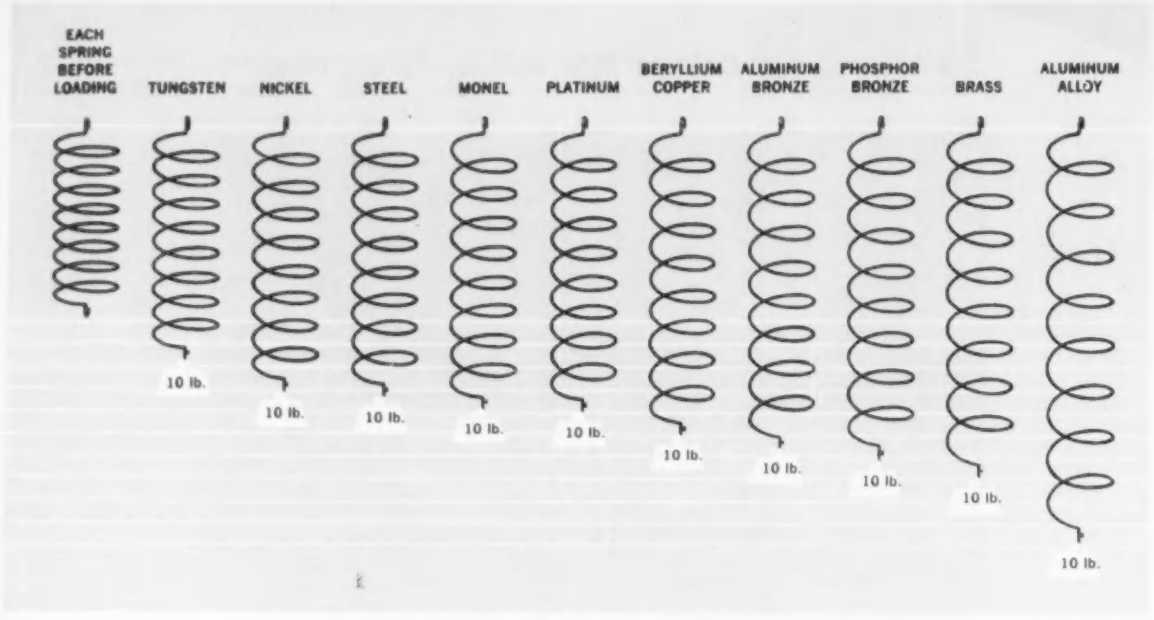
Available in standard sizes 1 to 6, 5 to 200 hp., larger sizes on request.

A-5627

ALLIS-CHALMERS

NEMA 50th Anniversary MOTOR & GENERATOR SECTION

Ultra-Speed is an Allis-Chalmers trademark.



How much deflection do you want in a spring ?

The wide range of stiffness characteristics available in different materials offer unusual opportunity to solve spring deflection problems. How wide is shown in the chart above. The tension springs are all of identical dimensions but of different materials and indicate the relative deflection obtained from applying the same load (assuming the stresses are within safe limits). This basic principle is often overlooked in the approach to spring selection not only of extension springs but other types: flat, torsion, etc. Because our daily work includes such a wide range of spring usage, we are in a position to help you in the early stages of spring consideration, both in material selection and production short cuts. A handy pamphlet to have at your elbow is our "Metal Selector." Write for your copy.

Associated Spring Corporation

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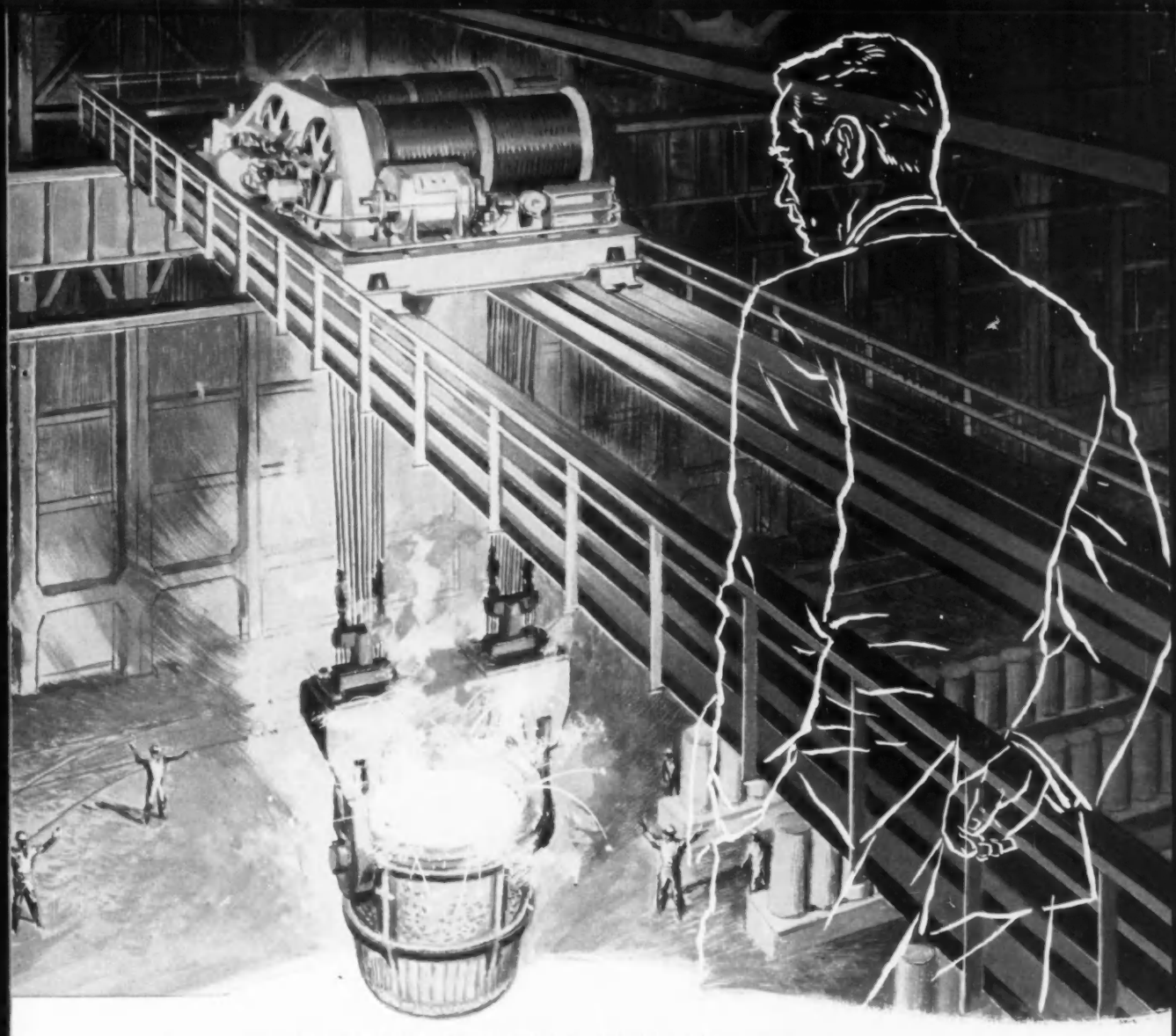

HOW THE SILICONES MAN HELPED...
ADD MUSCLE TO THE BRAWN THAT LIFTS A BUCKET OF STEEL

THREE HUNDRED tons of molten steel handled like a cup of tea. That's power with something to spare. But increases in production, the demand to do more work with small, compact equipment keeps electric motor design engineers on their toes.

The Elliott Company of Jeannette, Pa. is one of the leading suppliers of electric motors for steel mill applications. Recently, Elliott engineers wanted to increase overload capacity, life span, and resistance to corrosive atmospheres. They decided to use Class H insulation, and asked the Silicones Man to supply the necessary silicones. The result? A complete line of Class H mill motors with an expected life *ten times* that of present types! It's just one more example of how the specialized knowledge of the Silicones Man has helped solve an "impossible" problem.

Find out the latest information on silicones for Class H insulation or any of the other silicone products that solve problems of heat, cold, strength, corrosion. Call your Silicones Man, or address Dept. FP-6706, Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. (*In Canada:* Bakelite Company, Division of Union Carbide Canada Limited, Toronto 7, Ontario.)

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air circuitry:

a sales tool for you—Air is booming as an industrial control medium. Air Circuitry* has recently been applied to jobs where it never would have been considered a few years ago! Westinghouse pneumatic engineers have designed and installed Air Circuitry systems for original equipment which have boosted production and cut time and labor expenses for a wide variety of industries including electronics, textiles, automobiles, chemicals, and aircraft.

The benefits of advanced air control are well known among plant engineers. But you can apply these advantages with the same happy results in *your design* of machinery used in manufacturing operations.

SELLING ADVANTAGES—No other medium offers such safety . . . such dependability. Above all, only air can offer such economy: the medium is free and available in limitless supply; the devices are not expensive; and repairs can be made easily by unskilled personnel. These are all-important factors—factors which *sell* factory and machine shop supervisors!

SEE FOR YOURSELF. We'll send a qualified control engineer to your plant. He will show you if and how pneumatic control can improve your present design, and he'll estimate the cost of conversion. If we can't give you simpler, more reliable controls, you don't owe us a cent; our service is free.

Let us study your control systems. Let us improve them, with air. Just write to Westinghouse Air Brake Company, Industrial Products Division, Dept. DT5, Wilmerding, Pennsylvania. Give us a description of your line of machinery, and the type of control it is now using. We'll do the rest.

Remember, Westinghouse has led the world in the design and manufacture of pneumatic devices for more than 90 years. We bring world-wide experience to the solution of your control problems. We bring world-wide service to those who use machines equipped with Westinghouse Air Circuitry.

*AIR CIRCUITRY is the Westinghouse term for application of pneumatic control systems to industrial production operations.

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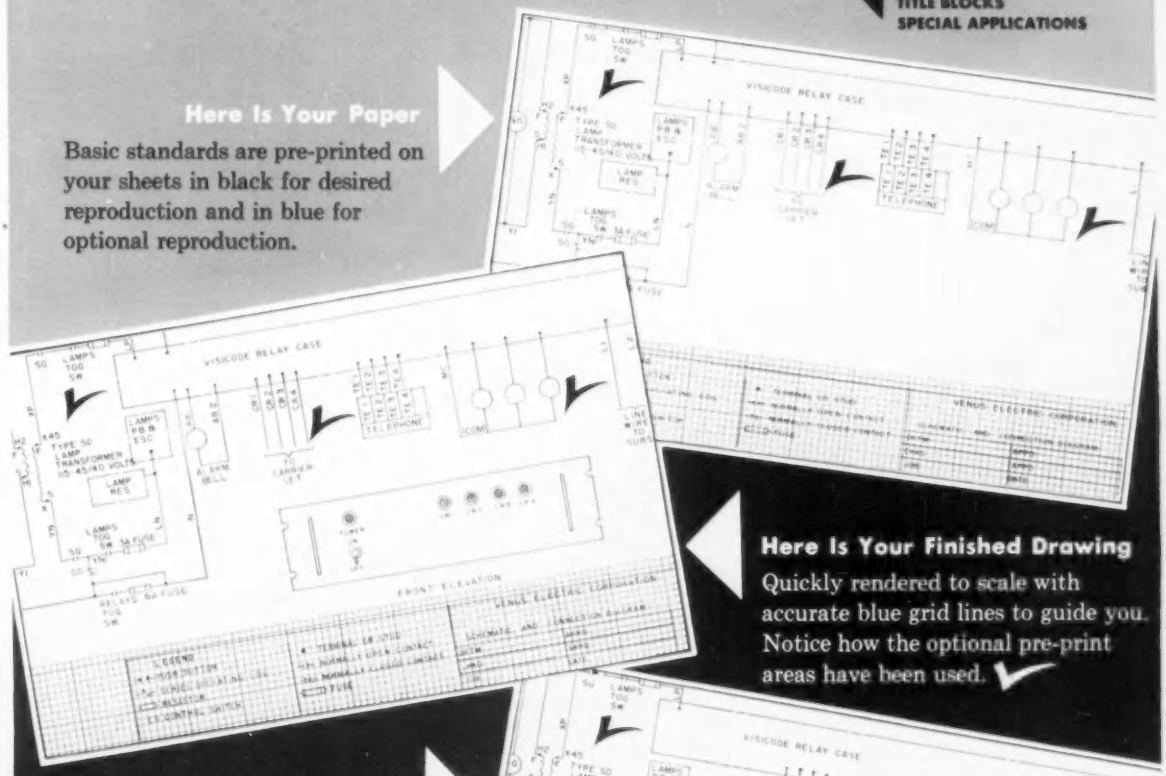

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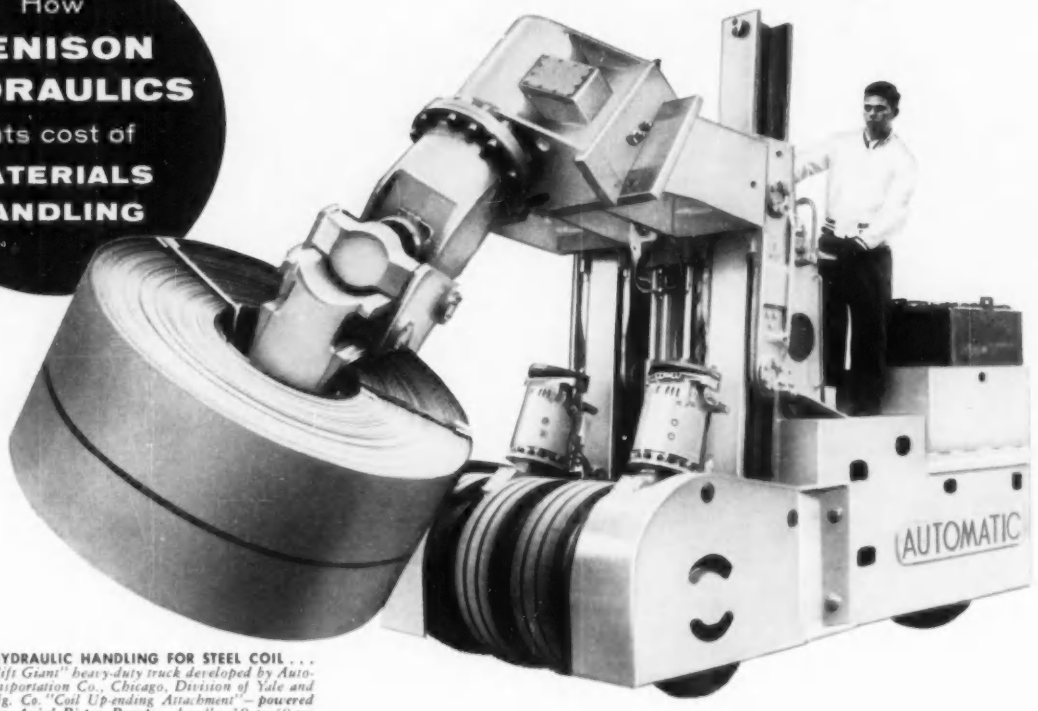
How
DENISON HYDRAULICS
cuts cost of
MATERIALS HANDLING



SPEEDY HYDRAULIC HANDLING FOR STEEL COIL . . . *on a "Skylift Giant" heavy-duty truck developed by Automatic Transportation Co., Chicago, Division of Yale and Towne Mfg. Co. "Coil Up-ending Attachment"— powered by Denison Axial Piston Pumps — handles 10 to 40-ton loads of steel coil.*

AUTOMATIC® trucks handle steel coil like a baby . . . faster, safer with **DENISON** hydraulic power

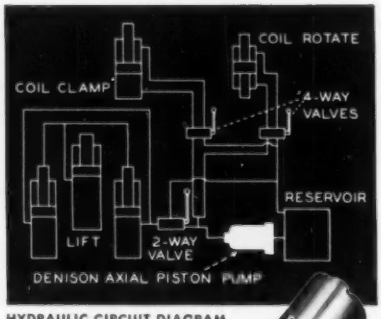
HERE'S the business end of a "Skylift Giant" industrial truck—equipped with a special "Coil Up-ending Attachment". Its jaws easily heft rolls of coiled steel weighing from 10 to 40 tons . . . *with Denison hydraulic power that pays off in smoother, faster, safer handling.*

In leading mills—these heavy-duty trucks speed handling and storage without damaging coils. The Coil Up-ending Attachment is designed to enter the coil's inside diameter with a fixed ram . . . while the outside is gripped by a powerful hydraulic clamp. This clamp-and-ram design prevents "telescoping" of coils during handling.

Three hydraulic cylinders—powered by motor-driven Denison 3000 psi Axial Piston Pumps — furnish lifting and clamping power. All three cylinders are connected hydraulically in parallel which results in a telescopic-cylinder action—but has the added advantage of retaining equal force and speed throughout the stroke at constant pressure and delivery.

Result: operator easily controls lowering speed at any level . . . and can inch the load up from extremely slow speed to maximum for which the flow control is set. *Safe, fast, smooth hydraulic control helps keep "Skylift" trucks continuously on the job . . . handling extra payload.*

Here's the kind of job your Denison Hydraulic Specialist can help *you* do *now*. Call him in soon . . . see how Denison hydraulic power can help put *more payload* into *your equipment*. Write us for details.



HYDRAULIC CIRCUIT DIAGRAM *. . . illustrates system for powering "Coil Up-ending Attachment". Denison equipment delivers hydraulic lifting and clamping power.*

DENISON 3000 PSI AXIAL PISTON PUMP

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1194 Dublin Road • Columbus 16, Ohio

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CIRCLE 135 READER SERVICE CARD →

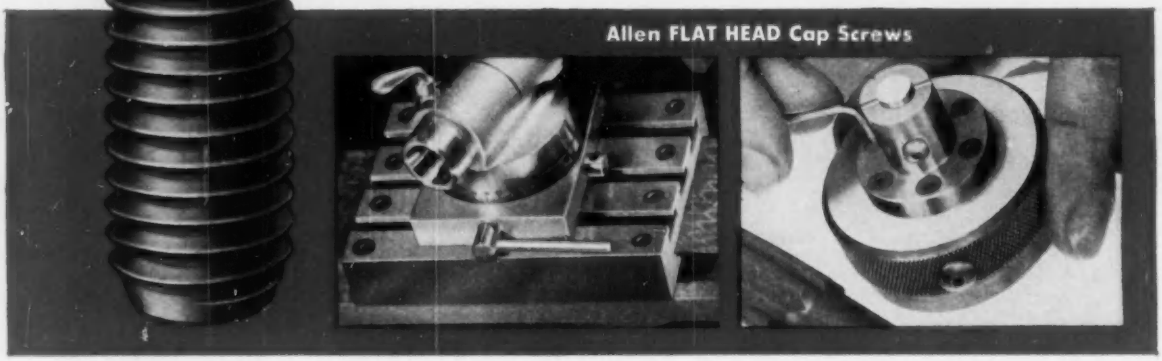
Design for full production efficiency: Continuous-Cast Bronze Castings.
Lower material costs, faster production, better products. Certainly a powerful set of reasons for evaluating Asarco's unique process of casting shapes in continuous lengths. The alloys produced by continuous casting are in accord with SAE, ASTM, and government specifications but their performance is demonstrably superior to similar alloys cast other ways. So superior in hardness, tensile, yield, and impact strength, that you may be able to substitute an Asarcon bronze for a high-cost aluminum or manganese bronze. You get the shape you need in the exact lengths you need, with minimum clean-up necessary, machinable on high speed machines. Immediately available in 260 *stock* sizes: Asarcon 773 (SAE 660) Bearing Bronze, solids and tubes, in lengths up to 105 inches. Write today for free booklet on Asarco continuous-casting to Continuous-Cast Products Department, American Smelting and Refining Company, Barber, N. J.; on the West Coast, Kingwell Bros., Ltd., 457 Minna St., San Francisco; in Canada, Federated Metals Canada, Ltd., Toronto and Montreal.

CONTINUOUS-CAST DEPARTMENT OF

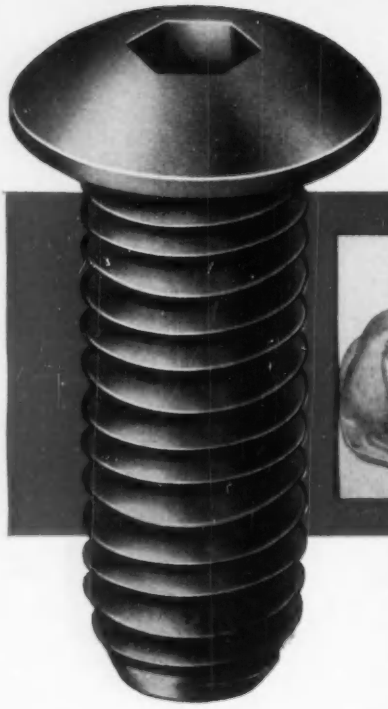
ASARCO

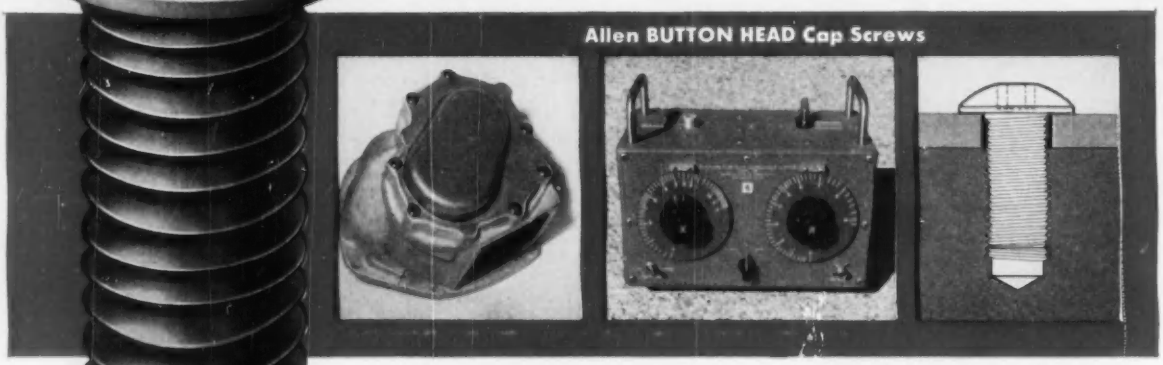
AMERICAN SMELTING AND REFINING COMPANY

Use genuine Allen tough-gripping fastening for your flush and streamlined surfaces



Allen Flat Head Cap Screws, in countersunk tapped holes, give you absolutely flush surfaces. Hex-socket wrenching entirely eliminates burred slots and protruding heads. Genuine Allen Flat Heads are "pressur-formd"—long fibers of the metal are preserved uncut throughout the whole length of the screw. Allen's exclusive Leader Point makes starting easier—prevents damage to lead thread. Class 3A fit; available in No. 4 through ¾" diameters. Write for FREE samples, dimensions, and full details.





Where you can't countersink—fastening thin metal parts like covers, access panels or guards, for example—Allen Button Head Cap Screws will give you the smooth, streamlined effect you want. Hex-socket wrenching assures a tighter hold—eliminates driver slips, raised metal slivers, and skids that can damage and mar parts and finish. "Pressur-formd," like the Flat Heads above, for far greater strength at vital points. Leader Point. Class 3A fit. No. 4 through ⅝" diameters. Write for FREE samples and full information.

The cost of Allen Hex-Socket Cap Screws is only a minor *fraction of your assembly costs . . . be sure you're getting* the timesaving, cost-saving advantages of *genuine* Allens.

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U. S. A.

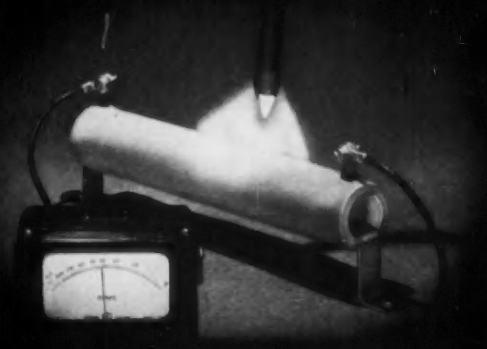
Stocked and sold by leading industrial distributors everywhere

ALLEN HEX-SOCKET SCREWS HEAD

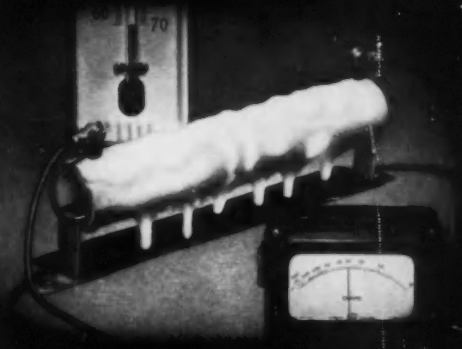
Opening in the late summer . . . Allen's new wonder plant!

CIRCLE 136 READER SERVICE CARD

CIRCLE 137 READER SERVICE CARD→



Stable operation from +700° F . . .



. . . to —70° F

Enamel resists active chemicals

Terminals withstand 21 lbs. pull

LABORATORY TESTS PROVE . . .

G-E resistors withstand heat, chemicals, stress

Actual laboratory tests on General Electric vitreous-enameled resistors have proved these important points:

Stable operation was proved by subjecting General Electric resistors to extreme ambient temperatures. Results of test: G-E resistors maintained their rated ohmic values under temperatures ranging from +700°F to −70°F.

Long operating life of G-E resistors is a result of sealing the windings with a special vitreous-enamel coating. This coating was tested with solvents, alkalies and other active chemicals. Result: no adverse effects from prolonged exposure to active chemicals.

Fewer replacements are necessary because of the sturdy construction of G-E resistors. Standard terminals hold up to 21 pounds of right-angle pull! (Special terminals withstand up to 34 pounds!)

Order G-E resistors today! Select from over 1400 combinations of ratings (5 to 200 watts), types and mountings.

NEED OTHER COMPONENTS?

General Electric also has complete lines of contactors, relays, and plate rheostats for all your control needs. For more information, contact your G-E Sales Engineer or mail this coupon today! Industry Control Department, Roanoke, Va.

GENERAL ELECTRIC

D-c contactors and relays—feature new "building-block" construction to give maximum flexibility with minimum inventory.

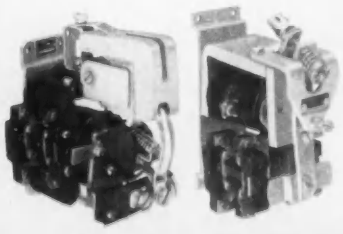


Plate-type rheostats—windings are completely encased in metal to give longer and more reliable service for any application.

To: Section D723-26
General Electric Co.
Schenectady 5, N. Y.

Please send the following bulletins:

- ☐ GEA-6592—Vitreous-enameled resistors
- ☐ GEA-6474—Plate-type field rheostats
- ☐ GEA-6621—D-c contactors and relays

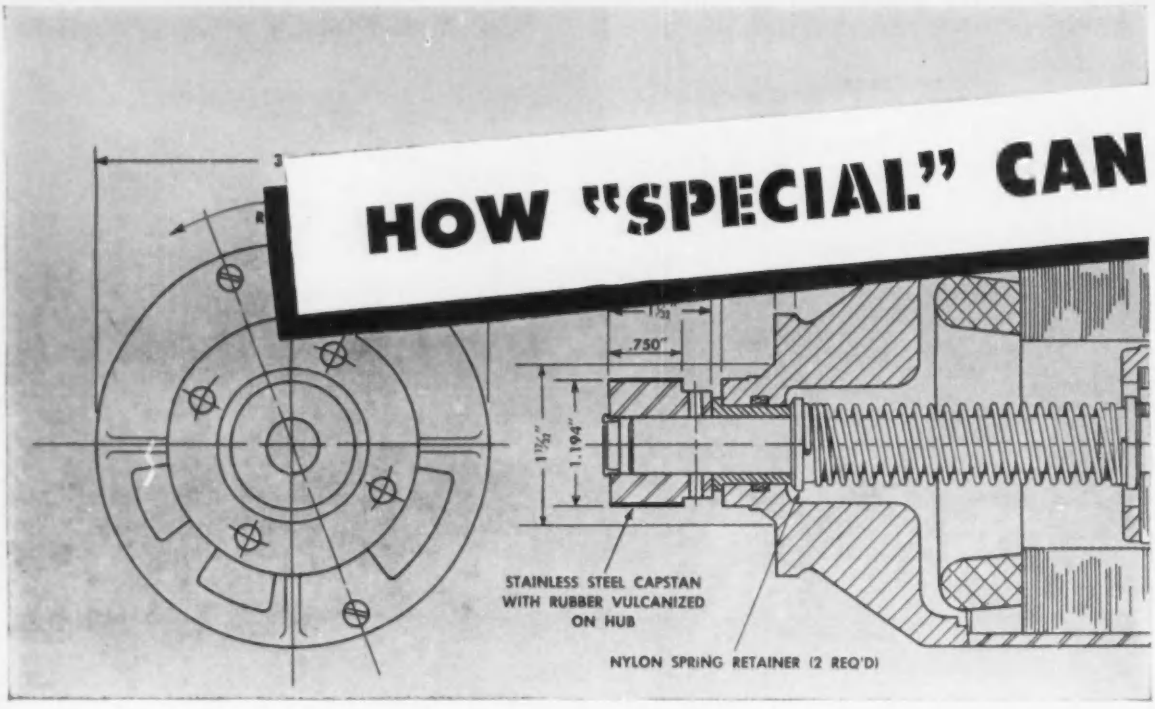
Name _____

Company _____

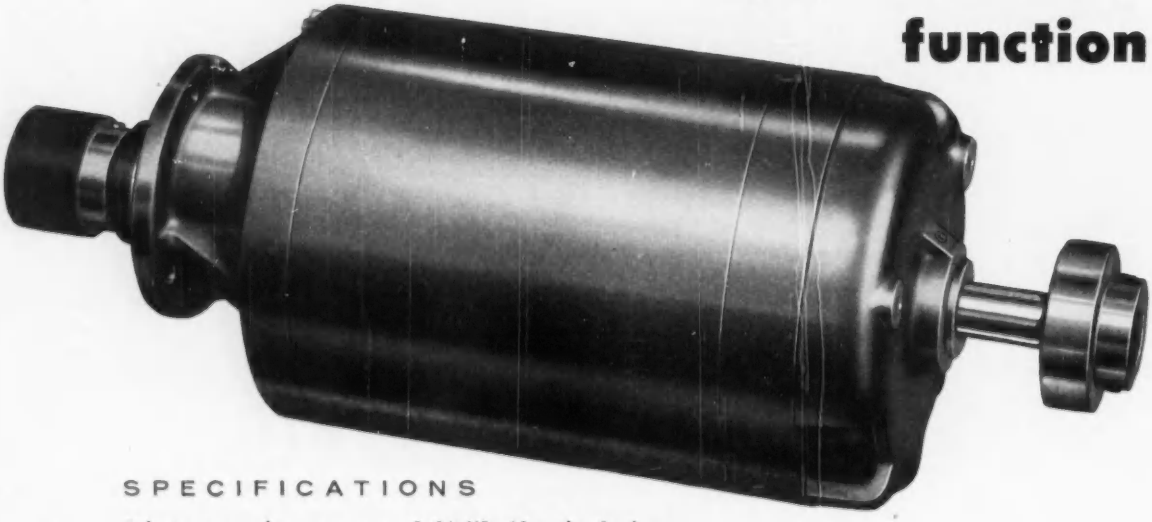
Address _____

City _____ State _____

HOW "SPECIAL" CAN



SPECIAL ROBBINS
capstan motors function

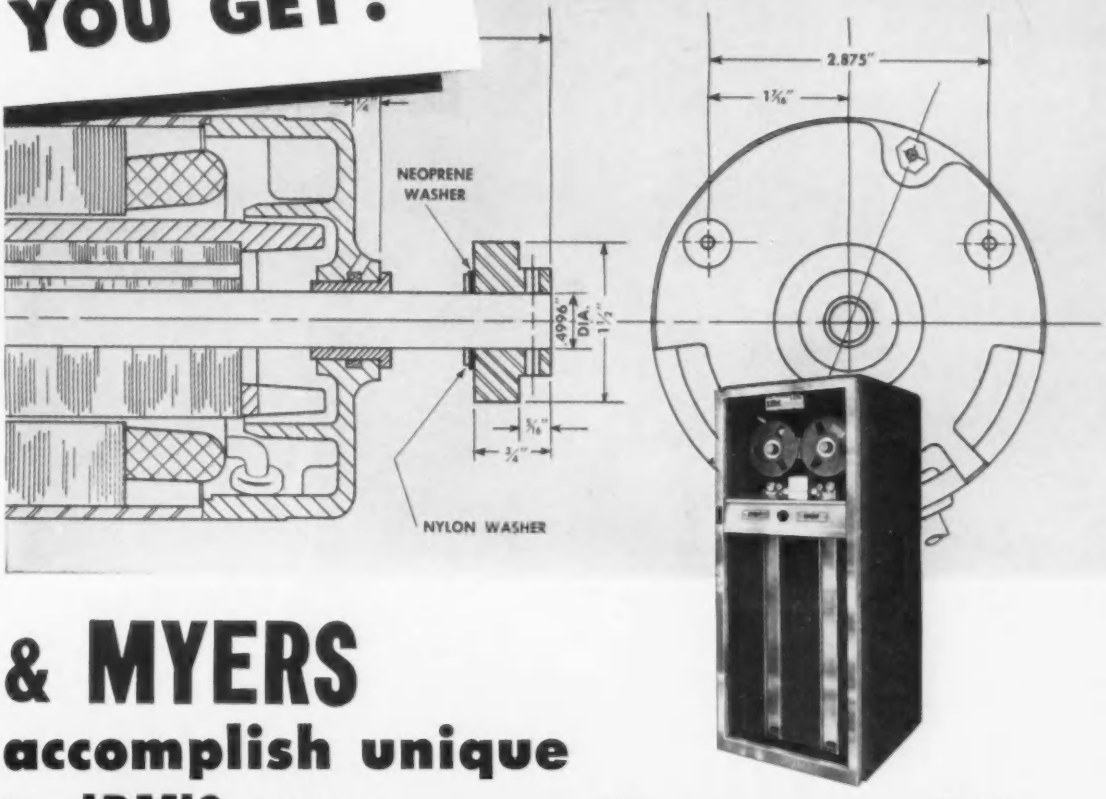


SPECIFICATIONS

Reluctance synchronous motor, 1/20 HP, 60 cycle, 3 phase, 208 volts ± 8%, 1200 RPM . . . Rotor dynamically balanced to commercial specifications . . . Shaft is shown in position when motor is stopped . . . When motor is running at synchronous speed, a minimum axial force of 350 grams is required with spring in place before displacement occurs . . . When rotor is in its retracted position and power is applied, the minimum axial force developed with spring in place is 100 grams . . . When power is cut off, the spring retracts the rotor with minimum 50 gram force while rotor is rotating.

Robbins & Myers builds motors from 1/200 to 200 horsepower

YOU GET?



& MYERS
accomplish unique in IBM'S 727 magnetic tape unit!

SHAFT ROTATES AND MOVES AXIALLY

Two of these special R&M motors are used in each of IBM's 727 Magnetic Tape Units. They answer IBM's need for a tape unit drive motor with a retractable capstan. The rotating shaft moves axially when the motor is started or stopped.

A spring holds the rotor, shaft and capstan in retracted position when the motor is stopped. When started, as the motor attains synchronous speed, axial force created as the rotor centers itself in the field becomes sufficient to overcome spring resistance. The capstan moves into engaged position and sends the tape reels rolling. Another capstan on the opposite end of the shaft (at right in drawing) actuates two microswitches as the rotor returns to retracted position when motor is stopped.

Four additional R&M fractional horsepower motors perform other high-speed power tasks within the tape units—driving reels, rewinding, unloading tape and retracting guide mechanisms.

R&M motors meet strict IBM engineering requirements: precise adaptability to special functions, capacity for lightning starts and stops, and absolute dependability. R&M can also design and build motors of highest quality designed to your exact specifications. For reliable fractional power, contact Robbins & Myers!

R&M

ROBBINS & MYERS, INC.
SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

MOTORS FANS HOISTS MOYNO PUMPS INDUSTRIAL & PROPELLAIR FANS

Resets at a Finger-FLICK...

runs at speeds up to 8,000 counts per minute!

Here's a new Veeder-Root high-speed predetermining counter *with instant resetting*. Easily preset to the required number of pieces or performance-units, the counter subtracts to zero . . . *then resets with a finger-flick back to the original preset number.*

This new counter meets standard U. S. electrical requirements (JIC Codes) . . . and is available with either electrical switch or mechanical stop. Also available *without the predetermining feature*, as a high-speed reset revolution counter. Series 1522 High Speed Predetermining Counters come in a rugged, handsome 2-tone gray case that looks well everywhere. *Write:*

EVERYONE CAN COUNT ON

Veeder-Root
INCORPORATED
Hartford 2, Connecticut

*Trade-mark registration applied for.

Hartford, Conn. • Greenville, S. C. • Altoona, Pa. • Chicago • New York • Los Angeles • San Francisco • Montreal • *Offices and Agents in Principal Cities*

THE FASTEST, EASIEST, MOST ECONOMICAL WAY TO CLAMP A HOSE

EATON-RELIANCE
HOZ-FAS-NERS®
Continuous, uniform pressure at all points.
One piece—no preassembling. Quickly installed—no screws to turn, no nuts to put on.
High-tension, spring steel. Plated to requirements. Round contour will not cut hose.

THE BEST INDUSTRIAL FASTENER FOR THE MONEY

Time savings alone are substantial when you compare Eaton-Reliance Hoz-Fas-Ners with ordinary hose clamps—yet these versatile hose clamps are superior in other ways. Exerting continuous, uniform pressure at all points they never loosen. They are vibration proof—never need adjusting or retightening. And they are good for longer than the life of the hose. Hoz-Fas-Ners are ideal for assembly line use where speed is essential, and they do effect savings even when hose clamps are installed occasionally. If your product requires hose clamps you can reduce your manufacturing costs and improve quality by using Eaton-Reliance Hoz-Fas-Ners. For details, write for Engineering Bulletin No. 1, or request one of our industrial fastener engineers to call.

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PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

NEWS FROM FLEXONICS

HOSE APPLICATION ENGINEERING

One of a series of reports on more effective use of flexible hose.

HOW TO SELECT FLEXIBLE METAL HOSE

Selection of a suitable metal hose for most industrial applications can be reduced to four simple steps: (1) thorough investigation of the application, (2) choice of an appropriate metal, (3) determination of the most suitable hose type, and (4) selection of the proper end fittings and method of attachment.

Nature of the Application

The word "STAMP" is useful as a check list of major application requirements:

S – Size hose?
T – Temperatures?
A – Application's nature including motions?
M – Media to be handled?
P – Pressures?

Size and temperature considerations are normally routine although it is sometimes imperative to consider maximum, minimum, average, working and test values insofar as temperature is concerned. Motions, however, frequently determine the type of hose to be used.

Bend limitations of corrugated hose are subject to the elastic limits of the metal. Bending an interlocked hose depends upon the motion obtained from sliding in the interlocked joint. Therefore, when motions are machine controlled or hose is to be permanently bent, specify a corrugated (Flexon Rex-Weld or Rex-Flex) hose. Also, choose a corrugated hose for positive protection against leakage from searching gases and liquids.

Interlocked (Flexon Rex-Tube) hose is generally used for manual operation

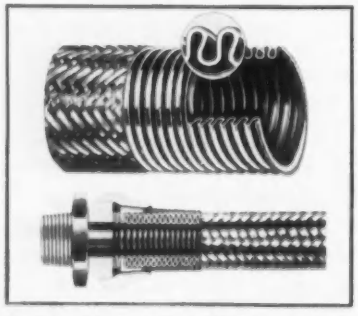


Fig. 1 — Typical Rex-Weld corrugated hose.

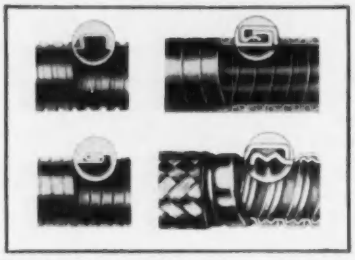


Fig. 2—Typical Rex-Tube interlocked hose types.

because the inherent design resists further bending when its minimum bend radius is reached. Using interlocked hose over a corrugated hose protects against abrasion or too sharp a bend to the corrugated hose.

Remember to specify corrugated (Flexon Rex-Weld) hose for: (1) searching or toxic fluids, (2) installations requiring sharp permanent bends, or (3) continuous vibration service.

Metal Selection

Metal selection is usually determined by the temperature and corrosive characteristics of the fluid being conveyed. Choice of a suitable packing for interlocked Rex-Tube hose is also a factor to consider.

Flexon hose specification tables give full data on maximum allowable temperatures. Past experience in handling a given medium is the best guide to selection of a metal with suitable corrosion resistance. However, bear in mind that corrosion rates acceptable for pipe could be ruinous to metal hose because of its relatively thinner wall. Consult Flexonics corrosion tables for detailed data.

Specific Hose Selection

The considerations outlined will have determined whether corrugated or interlocked hose should be used and the metal and packing required.

To determine which hose will be suitable concerning size, metal, pressure, weight, etc., consult Flexon industrial metal hose data tables in Flexon Metal Hose Design Guide. By using flexure data from these tables, the length of hose for any specific application can be determined.

Fitting Selection and Attachment

Fittings which are specially designed for soldering or mechanical attachment can be specified. Or pipe or tubing similar to adjacent piping can be selected for welding or brazing to the hose.

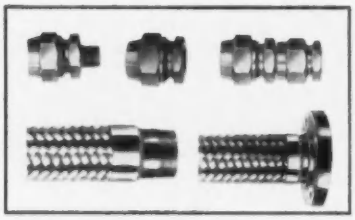


Fig. 3 — Typical metal hose end fittings.

Since the method of fitting attachment affects the maximum pressure and temperature rating of the assembly, it should be considered simultaneously with specific hose type selection.

Complete Selection Data Available

A new 36-page Flexon Metal Hose Design Guide expands the above data and presents the most complete information ever published on the selection and application of metal hose. It should be in every design engineer's reference file. Write for your copy, today.

G-38

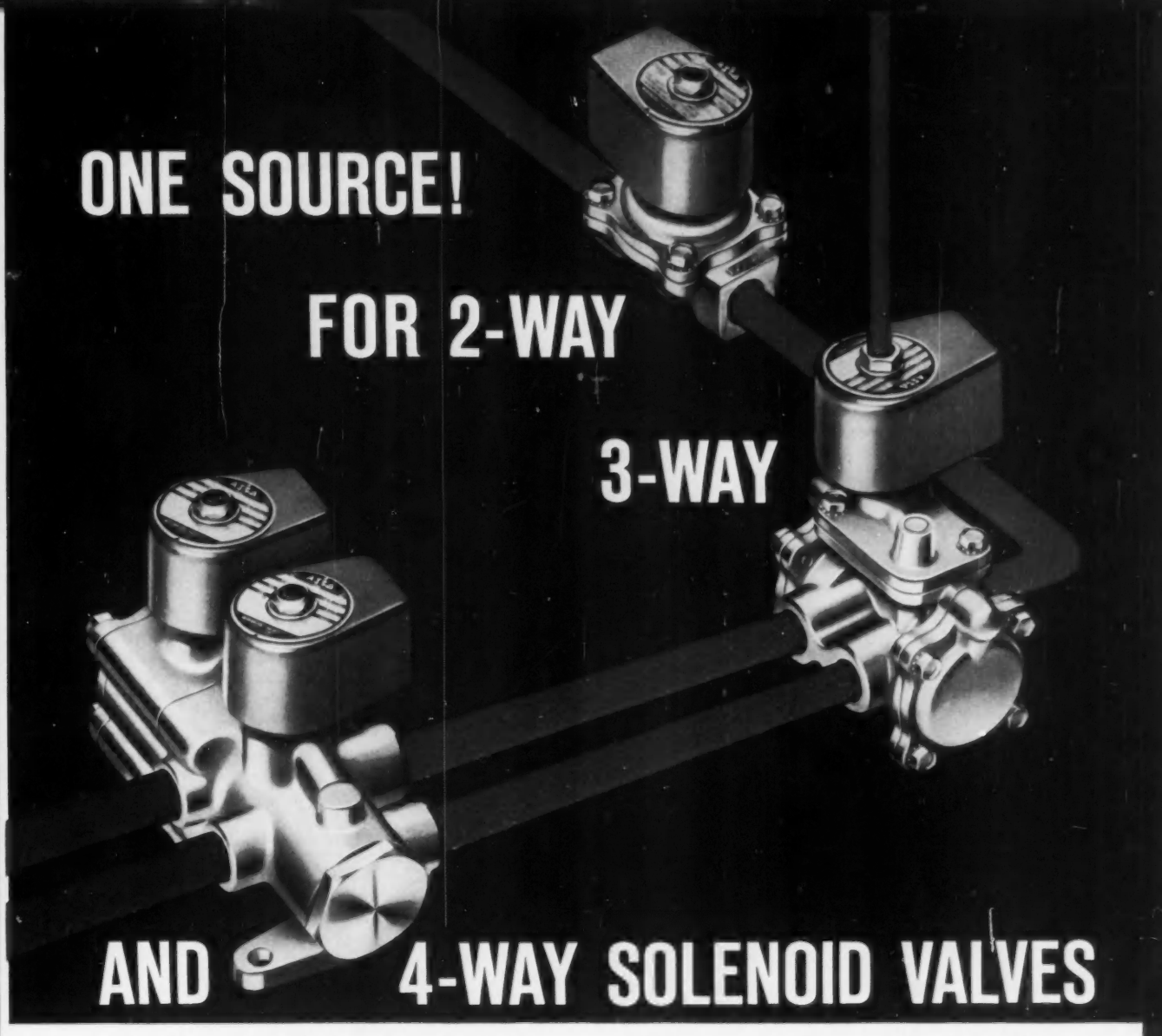
HOSE DIVISION

Flexonics *Corporation*

1351 S. THIRD AVENUE • MAYWOOD, ILLINOIS

In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario

Also Manufacturers of Rubber and Metal Hose Assemblies • Expansion Joints • Aircraft Components



When you discuss solenoid valve requirements with an ASCO engineer, you benefit from the design and development experience of half a century. The ASCO specialist can recommend the right valve for your needs because ASCO pioneering has brought about the thousands of types of solenoid valves now available:

Two-way valves in pipe sizes from ⅛" to 8"—for temperatures from -350°F to 600°F—for pressures to 5000 p.s.i.

Three-way valves in pipe sizes from ⅛" to 2"—for temperatures from -350°F to 600°F—for pressures to 1000 p.s.i.

Four-way valves in pipe sizes from ¼" to 1½"—for temperatures from -65°F to 212°F—for pressures to 750 p.s.i.—poppet or slide type.

And ASCO can supply you with standard, explosion-proof or water tight enclosures—Class A and Class H coils—a wide range of body materials including cast iron, brass, bronze and stainless steel. Or trade on ASCO experience and have one of our engineers call.

New! Catalog No. 202 covers the ASCO line of Solenoid Valves. Write for your copy today.

For Immediate Delivery...

World's largest stock of Solenoid Valves. A complete Solenoid Valve Stock List will be sent to you with your copy of Catalog No. 202.

Whatever the crucial factor in your flow control applications—reliability, compactness, high cycling rate—there is an ASCO valve that meets your need.

Automatic Switch Co.

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AUTOMATIC TRANSFER SWITCHES • SOLENOID VALVES • ELECTROMAGNETIC CONTROL

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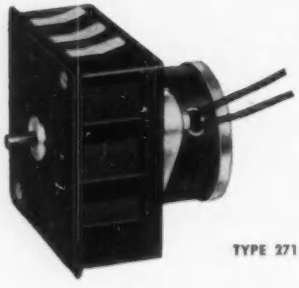
for cost-conscious manufacturers . . .

4 new solutions to timing problems

Over the years, Cramer engineering and manufacturing skill has built an unequalled reputation for quality in timers and timing motors. Today, the same skill . . . plus cost-cutting innovations in production methods . . . brings you four new units with the same outstanding quality at substantial price savings. Ask for prices, get the detailed specifications, and you'll see that Cramer quality means economy *now* — not just in the long run.

Cramer Controls Corporation
Box 7, Centerbrook, Connecticut

New Interval timer



TYPE 271

Cramer Type 271 is a compact, manually-set timer for "on" and "off" control of a wide variety of equipment . . . such as driers, ovens, photographic apparatus, battery charges, and various types of production machinery. Turning the dial pointer clockwise to the desired setting transfers the load switch, starts the motor and initiates timing. The pointer then indicates timing progress as it moves back toward zero. At the end of the set time, the load switch transfers to its first condition, and the motor stops.

TIME RANGES: 11 standard ranges, from 45 seconds to 24 hours.

LOAD SWITCHES: 1 or 2, as required; SPDT open blade.

CONTACT RATING: 30 amps resistive load, or ⅓ hp. motor load, at 115v A.C.

TIMING ACCURACY: within ½ of 1% of full scale time.

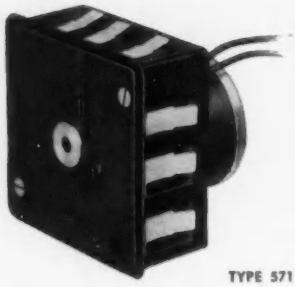
CONSTRUCTION: rugged, industrial design, using heavy-duty components.

POWER REQUIREMENTS: standard A.C. (50 and 60 cycle) and D.C. voltages.

MOUNTING: 2-hole face mounted, or single center hole.

WRITE FOR BULLETIN PB-271

New Cycling timer



TYPE 571

Cramer Type 571 provides reliable and inexpensive repetitive switching, or programming, in a wide variety of built-in applications . . . such as vending machines, displays, domestic appliances, production or process equipment, and many others. The timer starts when power is applied, stops if power is interrupted, and resumes cycling at the same point when power is restored. It can be wired for single cycle and stop operation, or for continuous cycling. During each cycle, 1 to 4 load switches are actuated, at times and for durations determined by cams cut to the user's specifications.

SPEEDS: 18 standard speeds, from 1 rpm to ⅛ rpd.

LOAD SWITCHES: 1 to 4 as required; SPST or SPDT, open blade.

CONTACT RATING: 30 amps resistive load, or ⅓ hp. motor load, at 115v A.C.

CAMS: precision-cut to user's programming requirements, locked to a square shaft that eliminates slippage.

TIMING ACCURACY: within 1½% of full cycle at each operating point.

CONSTRUCTION: rugged, industrial design, using heavy-duty components.

POWER REQUIREMENTS: standard A.C. (50 and 60 cycle) and D.C. voltages.

MOUNTING: 2-hole face mounted, or single center hole.

WRITE FOR BULLETIN PB-571

2 new timing motors

TYPE 117M

TYPE 117N

Cramer Type 117M and Type 117N are unequalled examples of performance-plus-economy in permanent-magnet synchronous timing motors. Delivering a full 30 in. oz. torque at 1 rpm, these powerful, accurate, reliable motors incorporate all of the engineering advances that have made Cramer the first choice of designers who put quality first. And their low cost is fast making them the first choice of large volume manufacturers who must put economy first. With standard gear train (Type 117M) or space-saving round gear train (Type 117N), a great range of standard speeds, and enough torque to handle the heaviest loads without extra linkages, they are ideal for appliances, vending machines, animated displays, timers, recorders, instrument drives, and many other applications.

SPEEDS: Type 117M—60 rpm to ½ rpd; Type 117N—60 rpm to 1/12 rpm. Special speeds available on order.

TORQUE: 30 in. oz. at 1 rpm.

GEAR TRAIN: fully enclosed, precision hobbed throughout.

OUTPUT SHAFT: stainless steel, selected to order from many standard or special forms available.

ROTOR: permanent magnet, with bronze oilite bearings and permanent lubrication; low rotor speed permits wide range of output speeds.

ROTATION: right, left, or dual (oscillating); patented "No-Back" mechanism; synchronous speed reached within 2 powerline cycles.

FRICTION: 1-way in rotation direction, or 2-way.

TEMPERATURE RISE: 35°C.

AMBIENT TEMPERATURE: −4°F to +131°F.

RATINGS: 115v and 220v, 60 and 50 cycles.

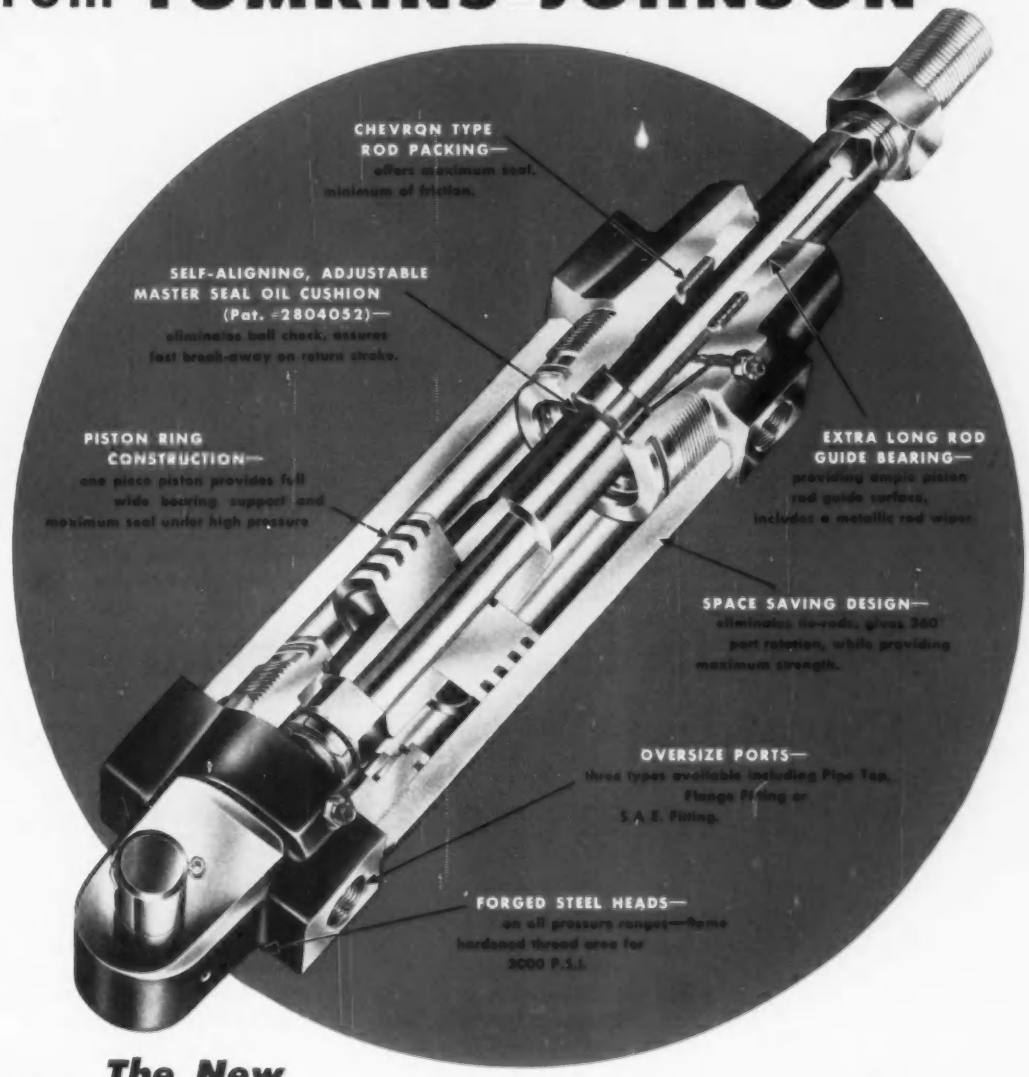
WRITE FOR BULLETIN PB-117

WHEN TIME IS YOUR PROBLEM, CALL CRAMER

CRAMER CONTROLS
CORPORATION

Another Engineering First

from TOMKINS-JOHNSON


CHEVRON TYPE ROD PACKING—
offers maximum seal, minimum of friction.
SELF-ALIGNING, ADJUSTABLE MASTER SEAL OIL CUSHION (Pat. #2804052)—
eliminates ball check, assures fast break-away on return stroke.
PISTON RING CONSTRUCTION—
one piece piston provides full wide bearing support and maximum seal under high pressure
EXTRA LONG ROD GUIDE BEARING—
providing ample piston rod guide surface, includes a metallic rod wiper
SPACE SAVING DESIGN—
eliminates tie-rods, gives 360° port rotation, while providing maximum strength.
OVERSIZE PORTS—
three types available including Pipe Tap, Flange Fitting or S.A.E. Fitting.
FORGED STEEL HEADS—
on all pressure ranges—flame hardened thread area for 3000 P.S.I.

The New T-J Spacemaker

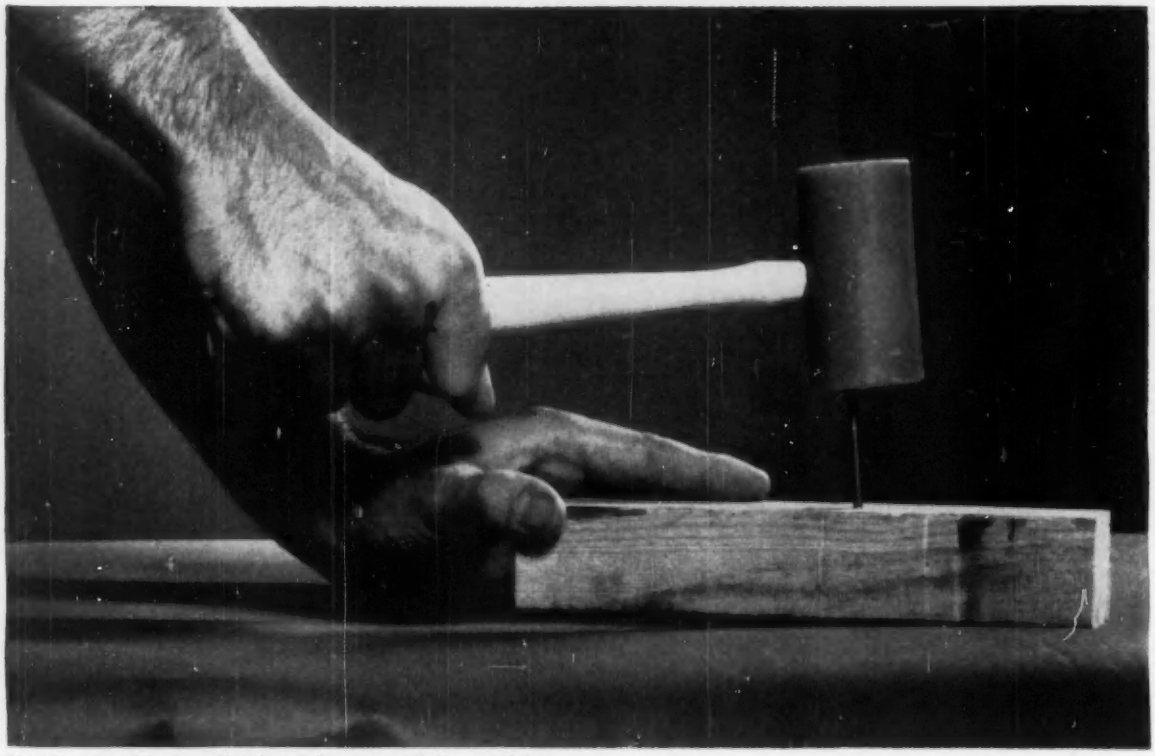
HIGH PRESSURE HYDRAULIC CYLINDER

- 1000
- 2000 P.S.I. Operating Pressure
- 3000

Truly another engineering first from Tomkins-Johnson, the new T-J Spacemaker High Pressure Hydraulic Cylinder will provide quality power performance at high operating pressures. ONLY T-J OFFERS YOU A HYDRAULIC CYLINDER WITH ALL THESE EXTRAS—*STANDARD,* AT NO EXTRA COST. Write to The Tomkins-Johnson Company, 617 N. Mechanic Street, Jackson, Michigan, for further details and Bulletin No. HSM-5-58.

T-J TOMKINS-JOHNSON

RIVETORS · AIR AND HYDRAULIC CYLINDERS · CUTTERS · CLINCHERS



Urethane rubber mallet head is so tough it can drive spikes through 2 x 4 without damage, yet so resilient a similar blow will not mar a polished table top.

New Urethane Material Combines Bounce of Rubber With Toughness of Metal

Resistance to high and low temperatures, common solvents, grease and oil make urethane rubber a natural choice for diaphragms, reservoirs and pump parts for industrial equipment.

. . . Gives Up To 10 Times The Wearability of Ordinary Rubber.

An entirely new kind of rubber, classed as a chemical elastomer, is being evaluated as the first elastic material that can qualify as a replacement for metals and plastics in industrial uses where a high degree of hardness must be combined with good flex fatigue resistance, exceptional toughness and wearing abilities.

Urethane rubber, extensively field tested in European automotive and original equipment uses, is now being commercially developed in this country by Mobay, a major supplier of urethane chemicals. In commercial application tests, the new material exhibits such a broad range of desirable engineering properties, plus unusual versatility in the way such properties as hardness and elasticity can be combined, that product engineers in many basic industries see in it the key to radical design changes in the industrial equipment field.

In one functional area, particularly, the triumph of urethane rubber over conventional rubber materials seems complete. In direct contrast to natural and other synthetic rubbers, the tear strength and abrasion resistance of the urethane product increases in almost direct proportion to the hardness

In addition to exceptional strength and abrasion resistance, the ease of casting urethane rubber in parts with difficult undercuts, slots, inserts and threads puts this material in the "work horse" category for designers and engineers.

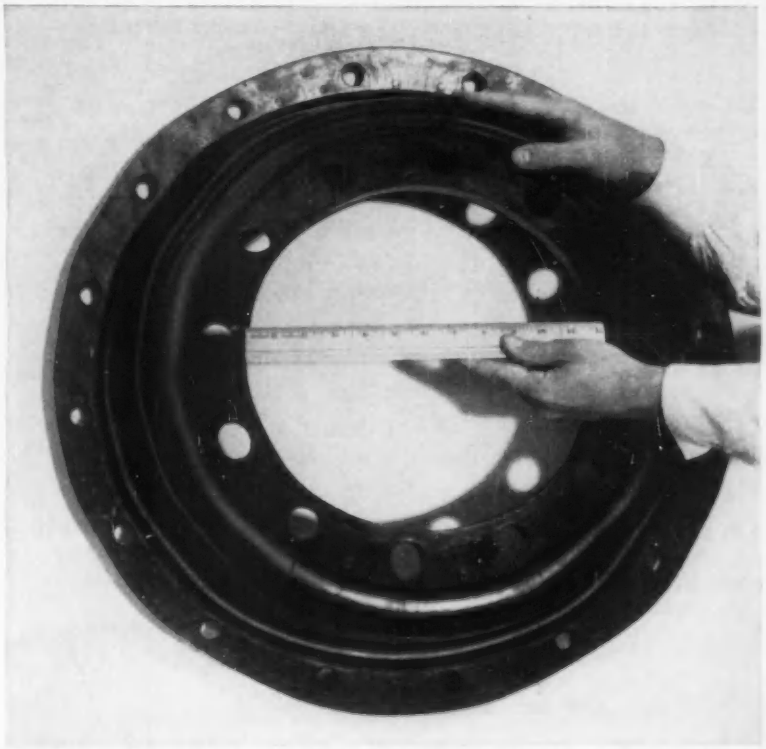
A high degree of flexibility and extraordinary tensile strength are among properties which may be combined for drive belts. Low abrasion loss, lower noise level and high coefficient of friction are additional advantages.

factor. In controlled laboratory tests, urethane rubber with a hardness value of 78-83 Durometer (Shore A Scale) was found to provide from three to ten times the wear resistance of other rubber materials in the same category.

In ordinary rubber, toughness is increased by blending in fillers which deaden elasticity, and by use of fibers which increase cost and reduce working properties. In contrast, the toughness of urethane rubber is achieved by modifying the molecular structure of the material itself which imparts an inherent stability to the end-product and makes precise quality control possible.

The superiority of urethane rubber over other types of rubber is unmistakable . . . in rebound elasticity, high and low temperature strength, elongation, resistance to solvents, ozone, acids and oxygen; in electrical properties and dielectric constant . . . and in other properties of interest in specialized manufacture.

Urethane rubber can be cast or machined to meet specifications for almost any configuration or contour, for such uses as oscillating bearing surfaces, automotive suspension systems, ball-joint assemblies, gears, grommets, vibration dampening devices, tools and industrial truck tires. Its exceptional strength and toughness make it an alternate choice for metals, in many cases, as well as an improvement over molded nylon and other rubber materials.



Huge flanged coupling for ship's drive shaft, cast of urethane rubber in one piece without reinforcement, will outwear ordinary materials many times.

For further information, technical assistance and sources of supply for urethane rubber, write to:

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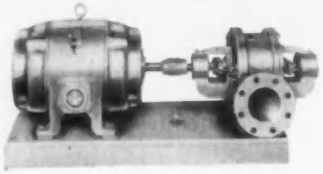

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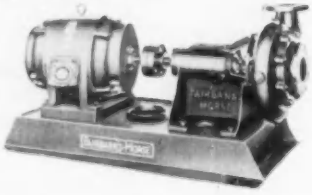

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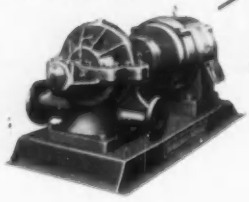

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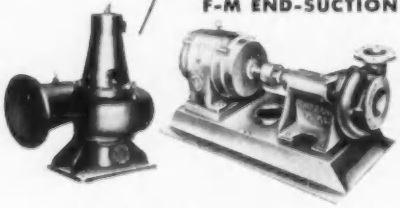

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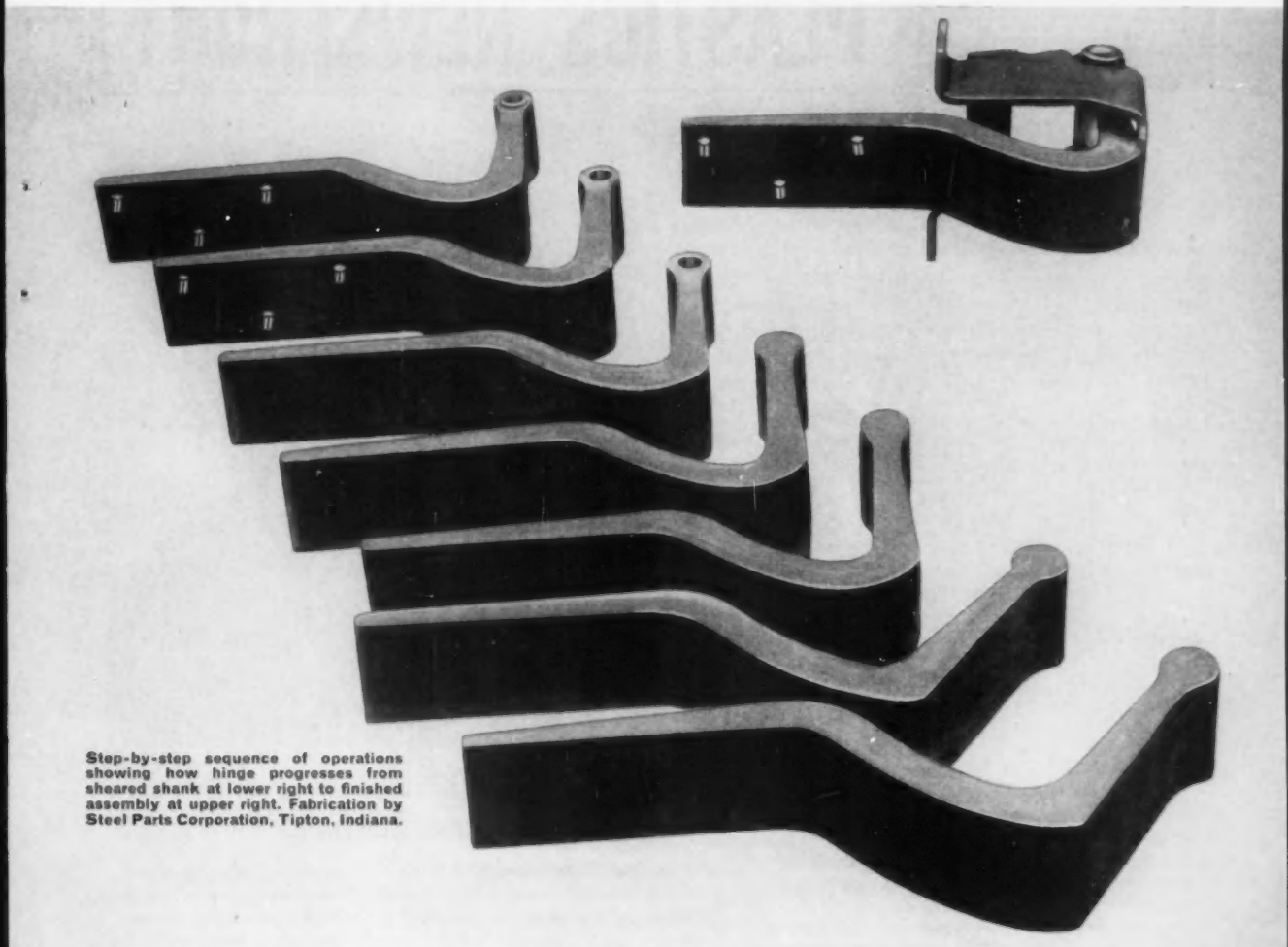
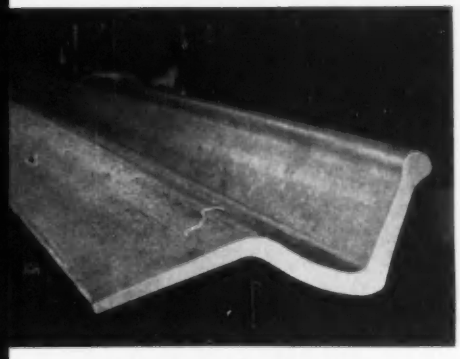


Step-by-step sequence of operations showing how hinge progresses from sheared shank at lower right to finished assembly at upper right. Fabrication by Steel Parts Corporation, Tipton, Indiana.

Auto door hinges made quickly . . . from steel already rolled to shape!



USS Special Section rolled to approximate dimensions of door hinge.

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CYANAMID

PLASTICS NEWSFRONT

Plastic Drink Dispensers Take Rugged Fountain Use

These attractive over-counter soft drink dispensers must resist impact, denting, corrosion, staining and scratching. So the Cornelius Company molds base, front and back panels of tough CYMEL® 1077 melamine plastic, which also provides the advantage of light weight—important in shipping and installing. Dispensers can be kept sanitary simply by washing with hot water and soap or detergent. Ordinary care will keep them bright and gleaming for a fountain's lifetime.

Lightweight and Portable— New Idea in Business Machines

This midget Underwood Add-Mate electric adding machine weighs just 7½ pounds. It can be toted easily from desk to desk or office to home, and slipped out of sight in a drawer when not needed. Contributing to its light weight, handy size, and durability is the attractive two-toned, two-piece housing molded of CYMAC® 201 methylstyrene-acrylonitrile copolymer. This plastic is tough, hard, and resistant to heat, staining and denting. Unharmed by the diester lubricant applied to the mechanical assembly, the CYMAC housing has the extra advantage of chip-proof molded-in color. This elimination of finishing simplifies manufacture.

Plastic Pipettes, Break-resistant and Boilable

Break-resistant, glass-clear droppers that can be boil-sterilized are among the growing number of products being made of versatile CYMAC 201 methylstyrene-acrylonitrile copolymer. Plastic Assembled Products, Inc. produces pipettes in sizes from 1½ inches to 3½ inches on high-speed injection molding machines, twenty-four units at a time. Dropper closures, in every color for quick product identification, are molded of Cyanamid's BEETLE® urea molding compound.

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PERSPECTIVES

in design and development . . .

Why Degrade Civil Service Work?

To Kenneth Kahn of Franklin County, Penna., who has worked both in private industry and in Federal Civil Service, the latter is not getting its share of good managers, engineers and scientists because of propaganda, rather than because of insufficient rewards. "Intentionally or mistakenly," he says, "the American people have arrived at misconceptions regarding Government service. For example it's not true that pay is low, red tape prevents useful work, no recognition is given to achievement, self-satisfaction is lacking.

"Many of the virtues of engineering work for the Government go unpublicized because of the apathy and selfishness on the part of the trained professional people in our country. Here is what I mean:

"College professors, employment counselors and professional people warn against Government jobs because of the stigma cast upon them. They themselves are reluctant to hire people who have been with the Government for more than a year. Result is the Government often gets what is left over. Right now the Government is getting some of the victims of layoffs. Many of these people are finding better jobs at higher pay than the ones they lost, and Civil Service is benefitting."

Mr. Kahn feels there is a dearth of real talent in all levels of Government. If there is no candidate for a job, the qualifications must be reduced or the jobs realigned—and this has been done much too often, according to Mr. Kahn. In rare cases, training programs have been established, but these are slow, costly, and not always successful.

"What does all this mean?" asks Mr. Kahn. "It means there are many excellent jobs going begging. Also, there are many officials who would be most happy if they could get competent help—and some who would be glad if they could get a competent boss."

A few agencies promote only from within in grades above GS-9. But Mr. Kahn feels this fallacy is becoming apparent and will probably correct itself if the Government receives its share of the potential first-class executives, engineers and other professional people it so earnestly desires.

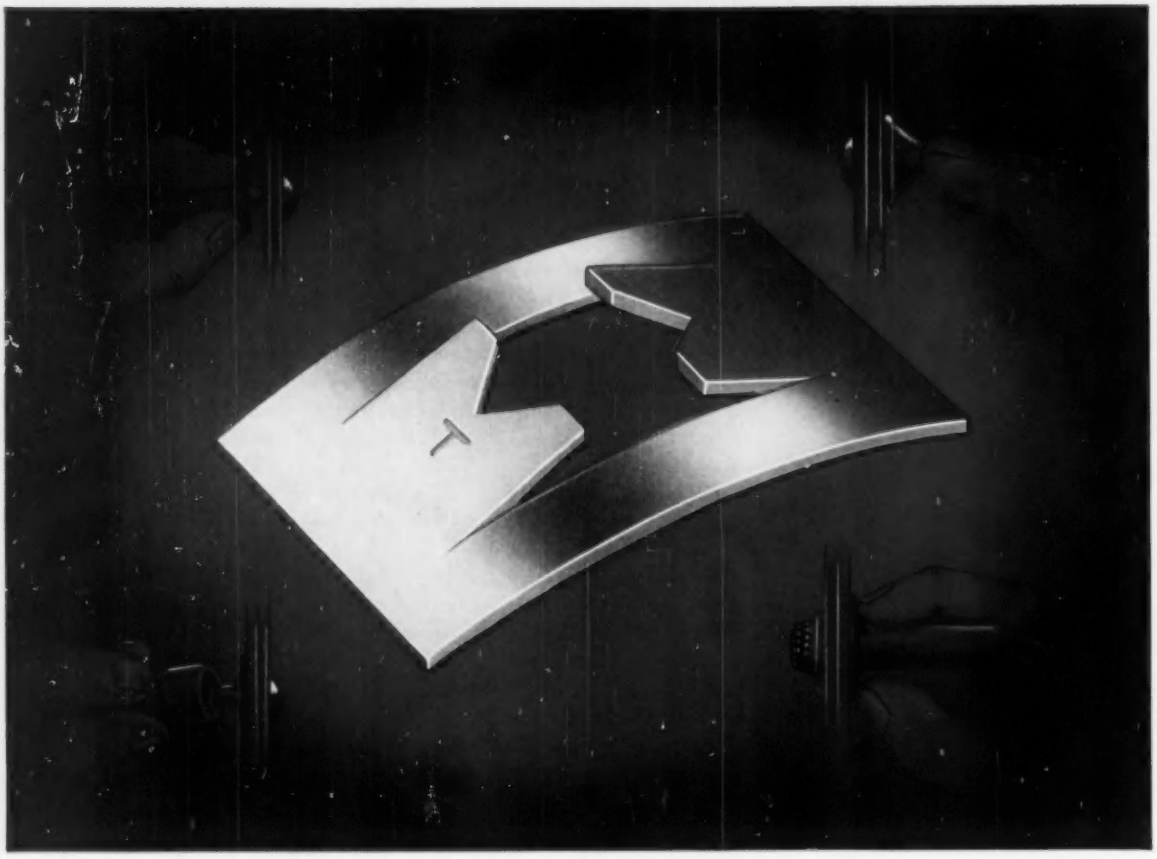
What's in It For You?

Civil Service regulations and policies provide: full credit for all successfully completed, qualified education; eligibility for advancement after a minimum tenure (usually one year) if there is an opening; opportunity to look for openings in any branch of our Government in any State and in many foreign countries; 13 working days of vacation annually, 20 days after three years' service, and 26 days after 15 years (military service included); a variety of job openings easy to locate with a minimum number of contacts; and a good opportunity for young college graduates to get varied experience in both scope and depth.

Mr. Kahn says that one must stay in Civil Service a year or two to learn its idiosyncrasies before reaping its rewards. Some will benefit by going first to it, then to private industry; and some the other way.

"Let's take a positive approach and advertise the advantages of Government employment," he says. "Let's applaud our civil servants along with the military. If Government service is good enough for some of our top industry leaders, it should be good enough for our professional societies to recommend to their members, and for technical magazines to assist."

We applaud Mr. Kahn for his forthright stand. —Paul Anderson



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Check Sweet's Product Design File, section 8-T. Or look under "Fasteners" in the Yellow Pages and call your Tinnerman representative for complete information and samples. Or write to:

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Product Engineering

HORIZONS

June 23, 1958

the Case-study Fallacy

To turn the objective into the subjective, the abstract into the concrete–in the minds of most of us, this step gives identity to a principle. The only problem is that we may end up with a case of mistaken identity.

A case study is just a case study–nothing more. It presumably resulted once in a correct solution, but may never do so again, particularly if people are involved. To quote an old bromide, "Circumstances alter cases." For example:

In one instance, a test lot of copper-bearing steel plates was delivered for forming. The supplier's laboratory tests showed the steel was hot short, that it should not be heated above 1800 F. And, sure enough, at that temperature, plate after plate tore in the press. Finally, the test crew heated up the remainder–and got perfect forming. Only the test clippings had been hot short.

Or again: "The very hard materials seem to be machinable at very high speeds, by materials of equal (not superior) hardness–much like a tornado puts a straw through a tree. The very brittle materials seem to be formable at high speeds too, or at very low temperatures.

These are examples of the available, documented case studies failing with inanimate objects. Add a person or, two, and the failure of the familiar case study as a guide in new circumstances is even more evident.

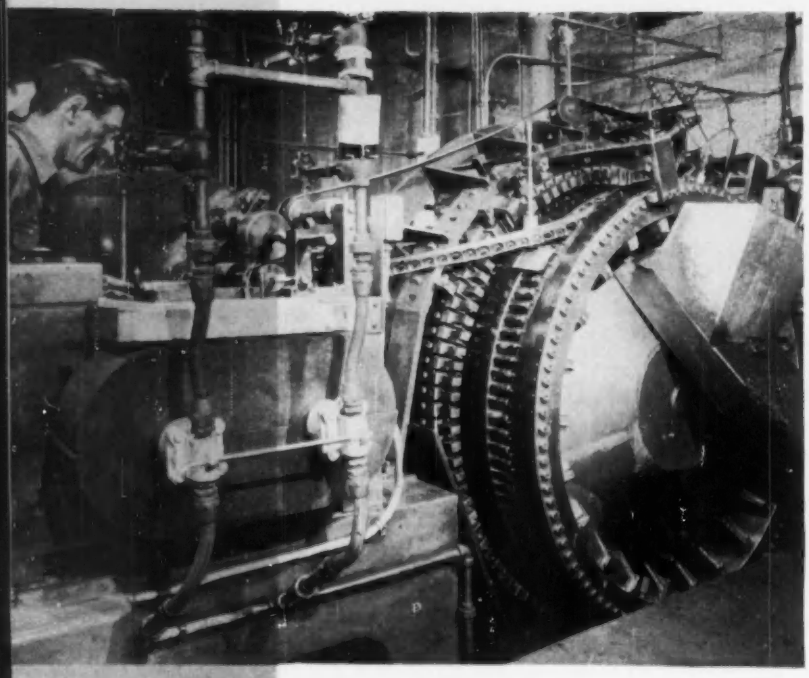
Greatest of the case-study approaches is the mass one–future planning. Consider all the planning that has been done, now knocked into a cocked hat by a change in the business climate.

How did it come about? Oldsters, remembering past disasters, set the youngsters to planning to avoid repetition. Then disaster comes–but a new kind that repeats few, if any earlier characteristics.

Yet planning is the current fetish, particularly planning of the long-term variety. Anyone who questions is confronted with "Make no little plans!" or "Don't sell the Blank Company short!" So the plans are made–and may be mistaken for a blueprint. And in the midst of the mutual admiration of the planners, the plans "gang aft a-gley."

The best-laid plans are those that are laid on the shelf when they don't fit. No amount of planning can be substituted for a little horse sense when the going gets rough. And no number of case studies culled from yesterday's problems will solve those of tomorrow. "Circumstances still alter cases," particularly in this dawning Age of Space.

K. Langeman



new

HIGH-SPEED MOLDING PROCESS cuts cost of rubber parts

R. L. HALSTEAD, *Manager*
Continuous Molding Applications
Ohio Rubber Company, Willoughby, Ohio

Automated assembly of products requires two characteristics not usually found in molded rubber parts—consistent, high, dimensional accuracy and low-cost volume availability. Hence the value of a new automatic molding technique called the Gora-Lee process. It produces rubber moldings to precise tolerances at the high rates necessary to low cost. Dimensions within ± 0.003 in. in both the fixed and closure directions are possible on parts produced at rates up to 200,000 pieces per day. All thermosetting elastomers are adaptable to the process—from the established nitriles to the newer silicone and polyurethane rubbers.

How Process Works

Key to fast production and high accuracy are 104 single-cavity, self-registering molds mounted in two vertical 48-in.-dia wheels as shown in upper photo. Mounted on a common axle, the outboard wheel contains the fixed mold cavities; the inboard wheel contains the movable force plugs. Each wheel is a steam chest which supplies heat for the cure. Compounded material is fed from a two-roll plasticizing mill (at left in photo) over conveying rollers and between the mold cavity and force plug—in open position at the top of the wheel. Actuated by spring-loaded toggles, each mold closes—punching out a precise quantity of material. The mold then passes through a complete molding cycle during one revolution of the wheel, with the finished part dropping into a hopper (at right) and onto a conveyor for a light post-cure, as the punched strip passes back to the mill for re-use. Where necessary, flash is removed by tumbling the parts with dry ice and wooden blocks.

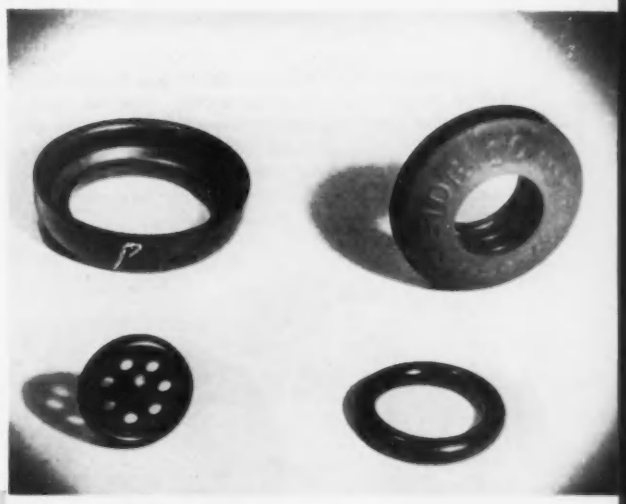
Some Pros and Cons

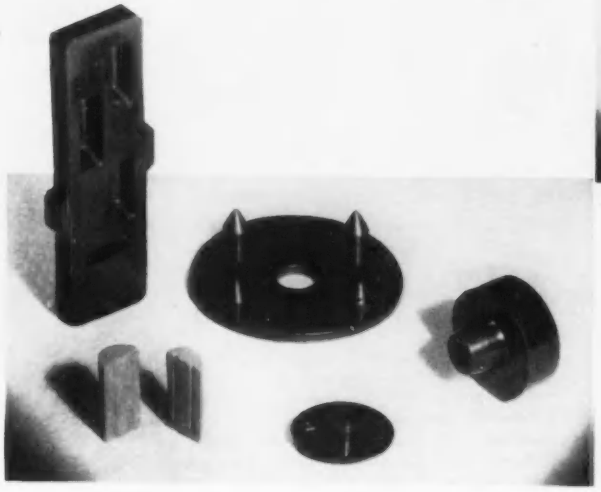
Advantages of the new process over conventional platen-type precision molding derive from the well-recognized advantage of single-cavity molds:

• Single cavities permit accurate, uniform application of pressure, resulting in uniform flash which gives greater precision and reduces finishing costs. Multiple-cavity platen molds are subject to thermal and mechanical warpage, making pressure control difficult. Close flash control allows the

Freedom from flash . . .

is critical feature of these precision parts. Uniform flash thickness, necessary for consistent flash removal, results from single-cavity feature of process plus good control of material thickness. Parts from left: (top) triple-landed universal joint seal, quadruple-landed seal for auto shock absorber; (bottom) aerosol bottle control valve, O-ring.





◂ Precision is key . . .

to high performance of these five parts. Top pair, from left: windshield wiper slide valve requires ±0.003 in. tolerance for parallel faces, location of ports and stop bosses; shaft coupling cushion must have parallel faces and precisely placed pin cups. Parts at bottom are designed for automated assembly. From left: detonator plug must fit copper cap precisely and half-holes must match; toggle valve requires dia concentricity to ±0.0025 in.; condenser cap must have uniform concentricity for high-speed assembly in metal shell, plus close tolerance ID for waterproof seal with lead cable.

same tolerances for all dimensions, whether along the force plug direction or perpendicular to it.

• Uniform material thickness, controlled by the plasticizing mill directly ahead of the mold wheel, assures precise and uniform charge to each mold. This, too, helps control flash and uniformity of parts.

• Process is continuous, not batch, permitting precise control of time and temperature for each part as it makes its complete circuit under the same pressure as its neighbor. Conventional platen molding, by contrast, requires two or three presses to be handled by one operator for any kind of speed, and identical cure for each part requires all presses to be functioning smoothly.

• Material is fed directly from the mill to the mold wheel, eliminating the conventional intermediate extrusion step which may overheat the stock and precure it. Direct feeding insures part uniformity and quality consistent with specifications.

• High production rate permits cost reductions for parts that require tolerances obtainable by other precision molding processes. For parts made by less precise conventional methods, performance can be improved through greater accuracy without prohibitive increase in cost.

• Two similar parts of different size can be produced simultaneously by alternating the molds upon the wheel. Thus a lower production run that might not be economical can be combined with a separate order. Separation of the parts is done by mechanical sorting in tumblers.

Process has limitations, too, that should not be overlooked when a manufacturing method is selected:

• Tooling costs and set-up charges are high, thus an annual consumption of about 500,000 parts is the rock bottom requirement for economical use of the process. Substantial economies can be realized at 1 million or more parts per year, and this latter figure is the best minimum quantity to shoot for.

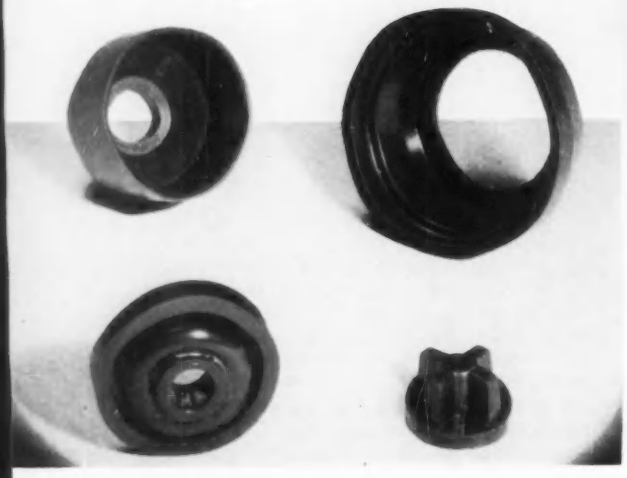
• Size of parts is limited by distance between the 104 die locations on the wheel. With present equipment, and with all mold locations occupied, top part diameter is about 1¼ in. This can be increased to about 2⅜ in. by half-tooling—mounting one larger die in the space formerly occupied by two—but production rate is cut in half. Max length of part with a through hole is about 1 in. and is controlled by the space between wheels and the throw of the force plug which must allow the part to drop out when retracted. Larger machines, under development, will ease these limits.

• Thin sections are required because about 90% of the cure takes place as the part makes its circuit—a time that can be very short at top production rates. Max permissible thickness is approximately ¼ in., although this varies with part geometry and compound used.

• High-tear-strength elastomers are required to prevent tearing of the part during ejection at high speeds. Thus the process cannot compete for producing parts

Problem parts . . .

show limitations of the process and design pitfalls. Pump valve seat (top), too flexible for amount of grommet undercut, tore when struck by ejector pins. Bottom, from left: auto shock absorber pivot was slightly heavy for fast cure; lamp grommet proved too massive for intricate shape, had insufficient area inside top lip for ejection without damage; suspension bushing was too heavy for quick cure, too long (1-1/16 in.) for fast ejection without jamming.



Hot fluids . . .

call for special compounding to maintain required properties, resist swelling. These parts made from Buna N are: (top, from left) auto valve stem oil deflector, centrifugal water pump shaft seal; (bottom) fuel pump push-rod seal, radiator thermostat valve plug.

like grommets, metal spacers, lamp boots where cheaper, lower strength rubber stocks are normally specified.

Materials to Use

Elastomers varying in Shore A durometer hardness from 45 to 95 are suitable. In general, higher-hardness materials are easier to use at high rates. However, very low-durometer parts are seldom called for, and a hardness of 50-60 covers the majority of applications.

Because high-speed production prohibits ribbon breakage, all elastomers used require special compounding to give the right handling consistency. This compounding, though different from that required in conventional molding, does not place limitations on final material specifications that can be met. Here, in order of preference, are the best materials: **nitriles and GRS** stocks are dry, do not require lubrication or excessive mold cleaning, and handle well; **neoprenes,** with lower durometer, tend to be mushy, and are difficult to handle because they dirty the molds; **silicones,** requiring some post-cure for best properties, are naturals for this two-step process, but they have poor handling qualities; **butyls** take longer cures and are thus more costly to mold; **polyether urethanes** are placed last because their use for high-speed molding has been least investigated.

Designing Parts

Beyond size and tear-strength limitations, design problems to be faced are basically identical with those met in high-speed injection molding of elastomers:

- Undercuts work best in holeless parts because the parting line can often be placed at right angles to the undercut, making part removal easier. Where this is not possible, the part must have adequate stiffness so the ejector pins can kick the part out without distorting or tearing it.
- Adequate bearing surface must be provided for the ejector pin, particularly in larger parts that tend to cling to the mold.
- Simplified geometry, particularly on deep hollow parts, makes tolerance control easier because the part then tends to cure evenly in the short time available in the mold.
- Selection of the right molding compound should be after consultation with the molder. In this way, part performance is assured, and all processing factors leading to minimum part cost can be considered.
- Metal inserts are possible, but this requires special feeding. Mechanisms to accomplish this are currently being developed.

EDITOR'S NOTE: Recent articles on elastomers include: "Ground Rules for Molded Silicone Rubber Parts," Apr. 14 '58, p 69. Covers characteristics of silicone rubber that can cause design problems. "High-Temperature Butyl," Nov 11 '57, p 90. Data compares HTB with five similar elastomers. "Cast Urethane Rubber," Sept 16 '57, p 68. Gives German experience and data on an abrasion-resistant elastomer.

NEW COEFFICIENTS . . . predict wear of metal parts

What are the effects of galling . . . poor oil . . . dust . . . surface cracks? These coefficients give answers that can lengthen life of a sliding system. With equations and other data are included examples of applications to design problems.

ERNEST RABINOWICZ, *Assistant Professor of Mechanical Engineering, Lubrication Laboratory, MIT*

Breakage will kill off the useful life of a mechanism. So will obsolescence. But there is a third important destroyer—the wearing away that afflicts all sliding mechanisms. For a long time, it was hard to describe on a quantitative basis; that has changed. Magnitude of wear can now be predicted with simple, general equations.

KINDS OF WEAR

Four distinctly different types of wear exist, each following its own laws:

- Adhesive wear—attraction between surface atoms of two contacting materials, leading to transfer of material from one surface to the other and eventually, to formation of loose fragments.
- Abrasive wear—removal of material by the filing action of a hard, rough surface against a softer one, or by abrasive grains trapped between smooth surfaces.
- Corrosive wear—similar to ordinary corrosion, except that the sliding dislodges products of corrosion.
- Surface fatigue wear—fatigue cracks in or near the sliding surface, leading to formation of large wear fragments.

Sliding may give either one or a combination of these forms of wear. The quantities are additive. One example is an automobile engine driven continuously—it undergoes predominantly adhesive wear. Under stop-and-start driving conditions, wear is mainly corrosive, owing to acids derived from impurities in the gasoline. On dusty roads, especially in absence of air and oil filters, abrasion becomes the main form of wear.

In a typical metal cutting operation, tool wear is predominantly adhesive. With chemically active cutting fluids, some corrosive wear also occurs; with a ceramic tool, wear is of a brittle or surface-fatigue type.

Sometimes types of wear directly influence each other. With fretting ("fretting corrosion") the first effects are from adhesion and abrasion. Oxidation or corrosion then hardens the fragments, especially if the contacting metals are steel. Fragments now act as abrasives, and finally the repeated stressing of points on the surface may lead to fatigue wear.

CALCULATING ADHESIVE WEAR

Adhesive wear, most important of the four types, is the only one present in all cases of surface contact, and is often the principal factor. A simple formula recently developed by J. F. Archard ("Contact and Rubbing of Flat Surfaces," *Journal of Applied Physics*, Aug. '53, p. 981) assumes there is a probability k that contact between protuberances on the contacting surfaces will produce a fragment. This concept has led to the following expression for predicting volume of wear:

$$V = \frac{kWL}{3p} \qquad (1)$$

where

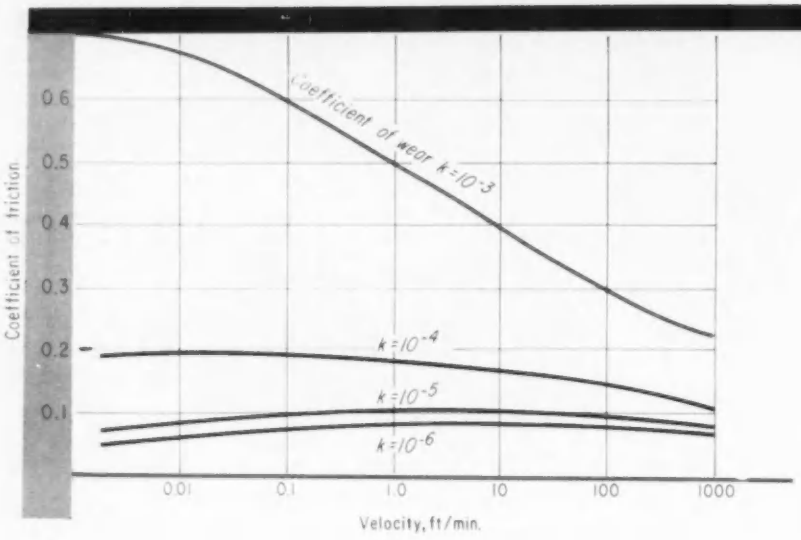
V = volume of wear, mm³; W = load on sliding surfaces, kg; L = sliding distance, mm; p = penetration hardness of the softer of the two contacting surfaces, kg/mm²; k = coefficient of wear.

Hardness can be measured on a Vickers, Brinell or Knoop tester and is always expressed in metric units. The other values can be given in English units by converting Eq (1) to:

$$V = \frac{kWL}{4260p} \qquad (2)$$

where V = in.³, W = lb, L = in.

Thus the wear volume is directly proportional to load and sliding distance, and other things being equal, inversely to penetration hardness. Constant k, nondimensional, is analagous to coefficient of friction. It should never exceed 1 (and never does in practice) because it was originally defined as a probability. Two important



Wear coefficients . . . can be read off this conversion chart when friction coefficient and velocity of sliding surfaces are known. Note that for low friction values, wear rate is almost constant with speed.

functions of the sliding system, surface finish and sliding velocity, do not appear in the above. Research suggests that, although they have some effect on wear, this effect is ordinarily slight.

It is depth of wear, rather than its volume, that is of concern in most practical applications. Also, penetration hardness in absolute units is not as generally known as is yield strength, which is approximately $\frac{1}{3}$ as great. Hence Eq (1) can be rewritten to give the wear rate of the softer contacting surface:

$$h = \frac{kWL}{9AS} \tag{3}$$

where

h = depth of wear, in.; A = surface area, in.^{2}; W = load, lb; L = sliding distance, in.; and S = yield strength of softer contacting material, psi. Wear rate of the harder material is less than the softer by the ratio:

$$h_2 = \left(\frac{S}{S_2}\right)^2 h \tag{4}$$

where subscript 2 denotes the harder material

HOW TO FIND k VALUES

It is best to calculate k from previous experience with the same or a similar sliding system. Failing this, a table of previously calculated values (see Table) can be employed—although the values are approximate.

A third—and possibly the most versatile—method of deriving k is based on the coefficient of friction: a function of the state of lubrication and the sliding velocity. The chart on this page was calculated for steel surfaces and long-chain hydrocarbon derivative lubricants, but seems to fit other materials quite well. Values of k can be read off the graph if the coefficient of friction and sliding velocity of the surfaces are known. At high speeds, use of the graph becomes risky—twin effects of thermal softening and hydrodynamic lift vary too much from one situation to another.

When comparing two similar systems, k values are not needed; for example, the equations show that changing the yield strength, load, area or sliding length will proportionally change the wear rate if other factors are kept constant.

Conditions of Lubrication

Conditions of the surfaces greatly influences K values. The table on opposite page lists four conditions.

Clean surfaces. These include surfaces carefully degreased, freshly produced by cutting or abrading in the absence of contaminants, or heated well above working temperature of any applied lubricant. Such surfaces produce "galling," "seizing," or "severe welding." Dissimilar metals generally do not gall; if conditions are such that they do, the k value for like metals applies.

Poorly lubricated. Here the surfaces are lubricated by totally unsuitable liquids such as water, gasoline, and (on steel surfaces) by ordinary silicones.

Average lubrication. Surfaces lubricated by ordinary machine oil, synthetic lubricants and the like.

Excellent lubrication. Fatty acids, soaps or greases, when present in adequate supply.

ESTIMATING ABRASIVE WEAR

Equations (1) to (4) also apply to abrasive wear if another constant, K, replaces k. Constant K is the average tangent of angle at which the abrader "bites" into the surface. Some rough but useful values of K follow for three types of abrader:

A sharp file	0.1
New abrasive paper	0.01
Loose abrasive particles	0.001

If the file is dull, the paper worn, the abrasive particles rounded, K values should be reduced by a factor of 10. These values indicate that abrasive wear rates may be several orders of magnitudes greater than adhesive rates of the same system.

ESTIMATING OTHER TWO TYPES

Corrosive wear. No simple expression for corrosive wear has yet appeared. Difficulties arise from estimating

Coefficient of Wear, k, for . . .

Condition	Metal on metal: Like	Metal on metal: Unlike	Nonmetal on metal
Clean	5×10^{-3}	2×10^{-4}	5×10^{-6}
Poorly lubricated	2×10^{-4}	10^{-4}	5×10^{-6}
Average lubrication	10^{-5}	10^{-5}	5×10^{-6}
Excellent lubrication	10^{-6}	10^{-6}	10^{-6}

Wear Equations: Why the Delay?

Until recently, the hidden aspects of wear resisted analysis because:

- Wear usually occurs at a slow rate. For example, by the time a 4000-lb automobile has travelled 100,000 miles to the junk pile, only a few oz of its total substance will have been removed at points of sliding contact.
- Quantities involved are small. For stationary contact, the transfer can be as little as 10^{-12} gm/lb, while even when some shear is present, as in banging a nail with a hammer or tightening a screw with a screwdriver, the amount rises only to 10^{-4} gm/lb.
- Wear tests are notoriously unproducible. Repeated tests often give wear rates that differ by factors of 2 and 3, and sometimes as much as 10. This may be caused partly by undiscovered systematic difference among test conditions, but is also caused by the inherently random nature of the wear process. For example, if two experimenters were to toss coins and to stop as soon as they had obtained "heads" 10 times, one might require 30 tosses and the other but 13, although test conditions were identical. With wear, some samples will be worn out after 13 units of travel or time, while others will last for 30.

Simple, workable equations have become possible because the situation has changed. New methods, including use of radioisotopes ("Radioisotopes–Seeing Eyes for Hidden Data," Mid-Oct. '53, p. A14), have made it possible to accurately measure small quantities of worn-away material. Careful experiments now show that all surfaces in contact–sliding or stationary–undergo some transfer and wear of material unless completely separated by a fluid film.

what fraction of the corroded layer is removed during every sliding pass, and how quickly the layer will re-form.

Surface-fatigue wear. Here, too, little quantitative work has been done: no clear-cut wear rate exists. Instead, there is an induction period during which the fatigue wear rate is zero, changing abruptly to a disintegration stage where the rate is very rapid. Because of the great size of these wear particles, it can be said that whenever surface fatigue and other forms of wear occur jointly, fatigue type predominates. And although heat-treating or work-hardening reduces adhesive and abrasive wear, it may increase surface fatigue wear.

WHICH MATERIALS WEAR BEST

Pure metals like copper or zinc, or alloys of pure metals like brass or bronze, have higher coefficients of wear–wear faster–than do metalloids like tungsten carbide or combinations of metals and nonmetals like cast iron. This is why anti-wear treatments for steel, such as nitriding and carburising, are so successful. They replace the metal surface with a metalloid—the carbide or nitride. Also, the treated surfaces are harder and wear better.

There is little distinction between metal and nonmetal or metal and metalloid surfaces in the presence of good boundary lubrication.

HOW TO APPLY THE EQUATIONS

Here are two practical applications of the wear equations, cited from various papers in the literature.

Wear in fixed gages. Chromium-plated test gages wore about 10^{-5} in. after 20,000 measurements of steel-cylinder bores. What is the value of k?

Wear of the gages is confined to a small raised circular region with an area 0.02 in.^{2} and a similar area on opposite end of the gage. Average force applied when inserting the gage into the cylinder is 2 lb and the gage moves 2 in. per test. The steel cylinder has a yield strength of 80,000 psi, and the chromium plate on the gages is probably four times as hard, hence liable to ¼ the wear.

Thus from Eqs (3) and (4):

$$1/2\ (10^{-5}) = 1/16\left(\frac{k(2)\ (40{,}000)}{9(0.02)\ (80{,}000)}\right)$$

$$k = 1.4\times10^{-6}$$

This seems a reasonable value for surfaces not deliberately lubricated. If not for the chrome plating, gage wear would be 10 times as great.

Wear in wire drawing. In drawing annealed copper wire through a tungsten carbide die, the die diameter increases by 10^{-4} in. per 15 miles of wire. The carbide is about 30 times as hard as the copper, the sliding distance is 10^6 in., and the depth of wear is 5×10^{-5} in. What is k?

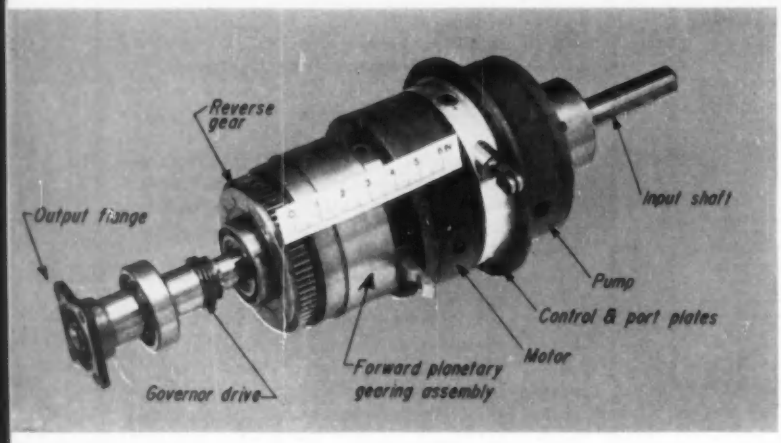
Pressure at interface of die and worked metal must equal yield strength of the worked metal (i.e. $W/A = S$). So:

$$5\times10^{-5} = \left(\frac{1}{30}\right)^2\left(\frac{10^6k}{9}\right)$$

$$k = 4\times10^{-7}$$

This value is close to the 10^{-6} postulated for surfaces lubricated by soaps and fats.

EDITOR'S NOTE: New wear-resistant materials have recently been discussed in: "Picking the Plastic for Abrasion Resistance," Mar 31 '58, p 105; "Gray Iron Castings," Jan 20 '58, p 52; "New Nylon Clads Sleeve Bearings," Mar 3 '58, p 52.



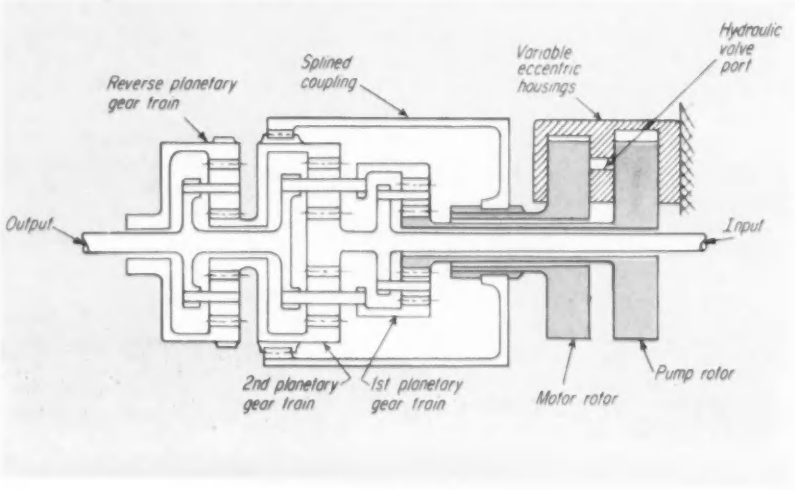
Positive displacement pumps . . . replace torque converter of previous transmission designs. Either pump is driven as a motor by the other, depending on torque and speed combination necessary to meet load demand. Flow of oil in closed circuit is controlled by a balanced, hydraulically actuated valve located between pumps. Valve position is determined by car speed, engine speed and accelerator position. Rotors of both pumps are centered on the input shaft; the slidable pump housings shift to vary pump displacement. The housings are moved to a new equilibrium position by the pressure difference created across the control valve when it is actuated to meet a change in load requirements.

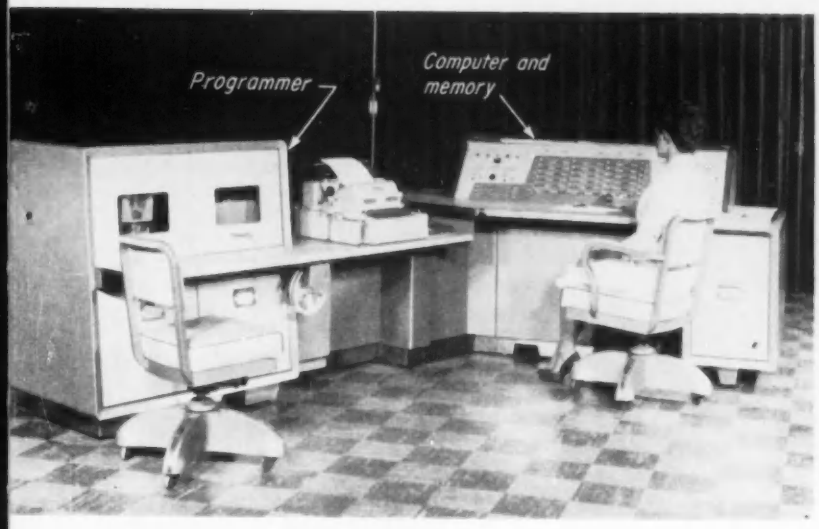
Vane Pumps Do Auto Transmission Job

Planetary gear trains interconnected by a closed hydraulic pump and motor circuit make a compact automatic transmission. Torque change is stepless throughout engine speed range.

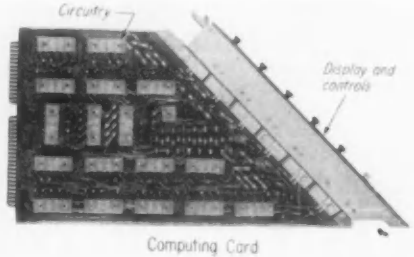
Fuel savings up to 25% are expected, and over-all efficiencies of 85-95% are obtained with this device developed at Motor Industry's Research Association, Nuneaton, England. Transmission is same size, weight and cost as a conventional clutch and gearbox. To date, prototypes have been made that transmit 50 hp.

Rotors are connected . . . to the forward gear trains. Pump rotor connects to sun gear of the first planetary gear train while the motor rotor is connected to ring gear of second planetary gear train by a splined coupling. This coupling can move rearward into a reverse planetary gear train. The input shaft drives the first two gear trains which, in turn, drive the rotor. Eccentricity of rotor housings is opposed so one pump freewheels when other is locked in the maximum delivery position. Front rotor and planetary train are locked for a 3:1 speed reduction; rear rotor and second gear train are for a 0.7:1 overdrive.





Speed and convenience . . . in operating plus simplicity and low power consumption were reasons here for extensive use of transistor circuits. Styling, function and engineering design are integrated to offer minimum distraction to the operator. Front panel has operations controls in a center section set off with a contrasting color. Controls and indicators for timing, ambient temperature and power are on operator's left; those for setting speed and mode of operation, and indicating faults, are on right. Computer's magnetic core storage holds 4096 words, each consisting of 36 bits (binary digits) of information. Operations are at rate of 50,000 per second.



Computing Card

Control Card

Transistors Give Desk-size Computer

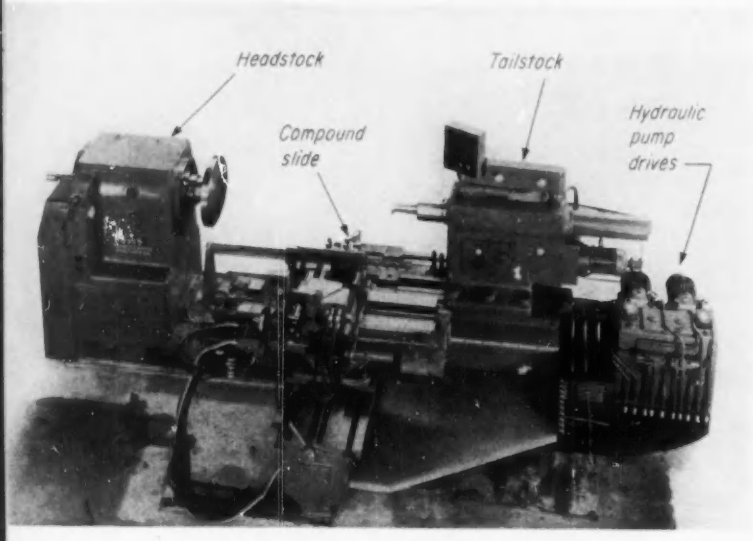
Here's a success story in miniaturization. With vacuum tubes, a "brain" able to match the work of the 10,000 transistors in this unit would fill a large room.

Designed for solving otherwise tedious mathematical problems, the completely transistorized computer is small and offers these other advantages — reliability, high speed, low power consumption. Called the Transac S-1000, it plugs into a standard 110-v wall outlet. Manufacturer is Philco Corp.'s Government and Industrial Div.

Arithmetic operations . . . are performed by 36-bit functional computing circuits on cards in top level of console. Other cards, with circuitry for selecting and controlling the computing circuits, are in racks under operator's desk. Both types of cards are plug-in printed circuits.

Functional cards include controls and readout display to simplify manufacture and make unit compact. Random circuitry on these cards gives maximum density of components.

Control cards, however, have grids made with horizontal circuit paths on one side and vertical paths on the other. Connections are made by drilling through board at proper coordinate, inserting a feed through wire, and soldering. All circuits use surface-barrier-type transistors.



Tailstock and slide . . . move together on the carriage. It has static-pressure hydraulic bearing surfaces that lift it to reduce friction when it is moved. Hydraulic cylinders clamp the carriage to the ways before forming begins.

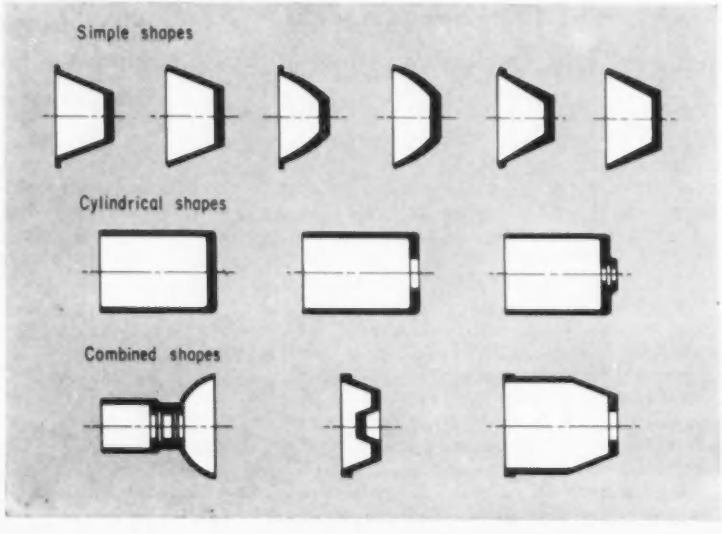
The compound slide swivels 360° on its base plate and locks with a feed screw. All slide motions and the principal clamping devices are actuated hydraulically, though by separate systems. Carriage is positioned by a lead screw driven by a hydraulic motor. Headstock spindle is driven by a 20-hp motor through a 1:5 ratio, infinitely-variable belt drive. A 3-step transmission increases speed range from 10 to 630 rpm.

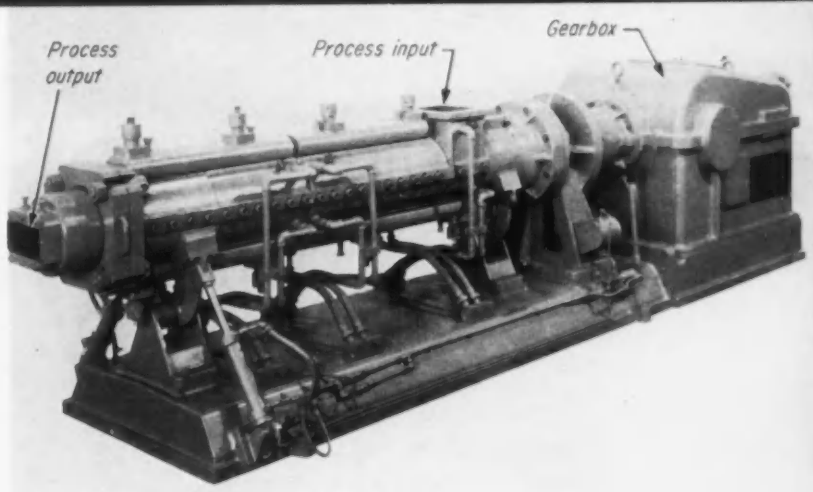
5 Hydraulic Circuits for 3-Job Machine

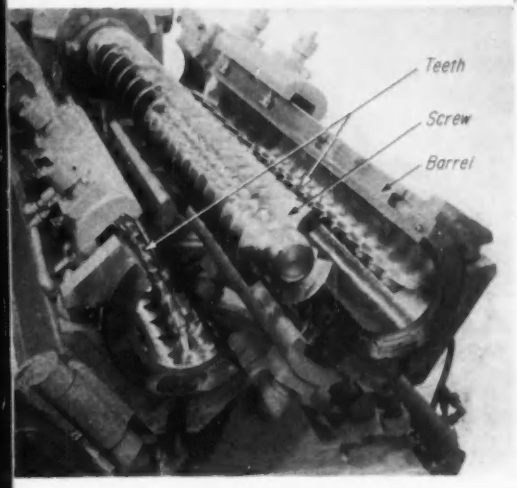
Separate power systems position tailstock, carriage and compound slide for machining, spinning and flow-forming. Result is better accuracy and finish on parts.

Universal design was found best for producing modern products that often require all three operations. Machine built by Bohner and Aohle, Esslingen, Germany, is distributed in the United States by the Kurt Orban Co., Inc., Jersey City.

Machine spins metals . . . with a maximum diameter of 60 in. into hollow parts up to 40 in. long. Aluminum up to 1½ in. thick and stainless steel ⅜ in. thick have been spun. Forming ability varies with the shape desired and the material. Blanks can be sheets or premachined forgings or castings. Tracer system varies force on tool to hold thickness constant.





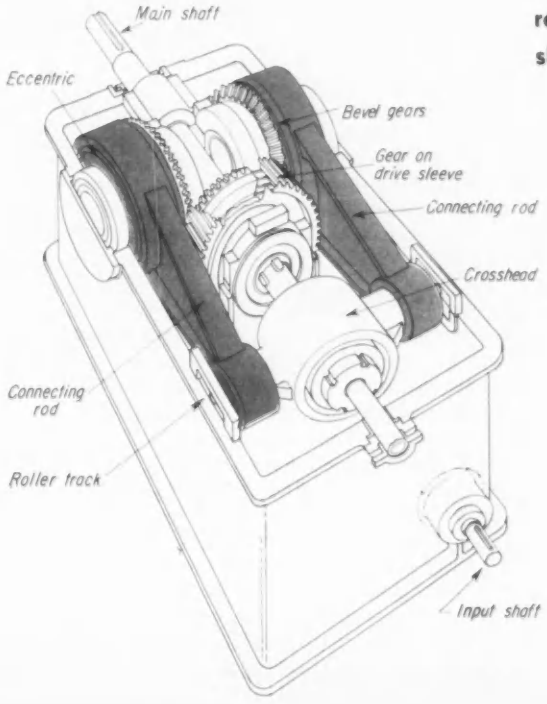


Kneading action . . .
is accomplished with an interrupted-thread screw running in a cylindrical chamber ("barrel"). Chamber has 3 rows of fixed teeth that pass through gaps in the screw as it rotates and reciprocates. The fixed teeth retard the forward motion of a part of the mixture each time the screw cycles, causing particles to flow through the chamber in a series of loops. This action gives a high degree of mixing with a short retention time.

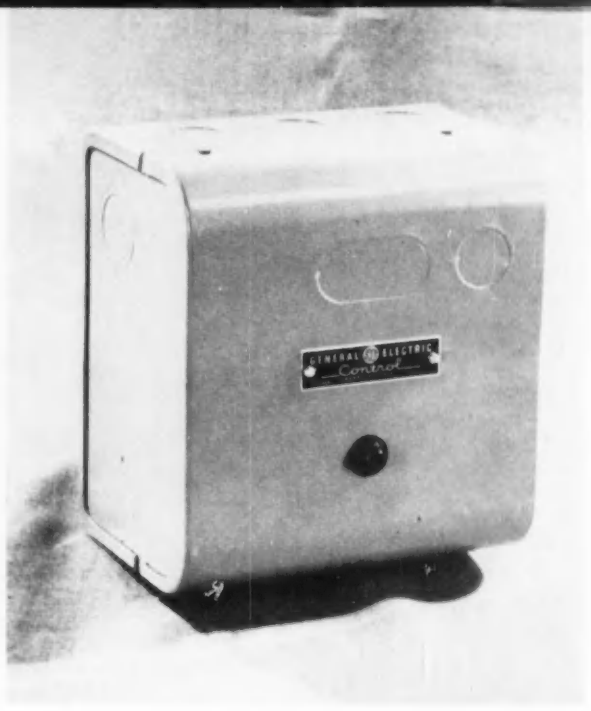
Conveyor Kneads As It Pushes

Kneading screw of this continuous mixer reciprocates while rotating. Combined action shortens mixing time and improves product.

Objective was to design a continuous process machine with adequate mixing action. This was done by combining reciprocating and rotary motion in the action of the screw that forces the material through chamber of the machine. Mixing-screw kneader is made by Baker Perkins Inc., Saginaw, Michigan.



Combined motions . . .
are generated in gearbox at input end of machine. The power input shaft drives an internally splined sleeve keyed to the main drive shaft. This shaft is, in turn, keyed to the mixing screw. The sleeve, through bevel gears, also drives two eccentric shafts. These shafts and their connecting rods drive a crosshead connected to the main drive shaft through roller thrust bearings. The bevel gears have a 1:1 ratio, so the screw completes one reciprocating cycle for each revolution.



SIMPLEST ENCLOSURE is NEMA Type 1. This one is 8 x 10 in., with front cover removable to get at magnetic device.

ELECTRICAL:

CONTROL ENCLOSURES
that meet industry standards

Besides containing, mounting and protecting controls, enclosures must meet several sets of standards. Here is a guide showing how to satisfy the requirements.

F. L. TEUSCHER, *Industry Control Dept., General Electric Co.*

Two essentials have to be met when designing or specifying enclosures for electrical control devices and equipment. Enclosures must meet operating requirements. And they must satisfy rigorous application and safety standards set by industry groups and insurance underwriters.

Variety includes enclosures small enough to be held in the palm; others extend to 15 feet or more. Cabinet or desk-type configurations become operators' stations—with pushbuttons, selector switches, rheostats, gages, and other pilot devices. If manual control is main function, enclosure may be called operators' cabinet, control desk, or console, depending on shape.

Other requirements, to protect both the novice and careless expert from accident, are set up by NEMA (National Electrical Manufacturers Association), JIC (Joint Industry Conference, sponsored by automotive manufacturers), and UL (Underwriters' Laboratories).

A DOZEN ENCLOSURES

NEMA Standards for Industrial Control define 12 basic enclosure types . . . accepted by major manufacturers.

Type 1—General Purpose. Suitable for majority of indoor applications. Under normal atmospheric conditions, affords some protection from dust particle accumulations but is not dust-tight. Gaskets optional.

Type 2—Driptight. Protects control equipment, for indoor applications, against falling liquids such as condensation from cooling pipes. Requirements are often met by adding drip shield to Type 1 enclosure.

Type 3—Weather Resistant. Outdoor-type enclosure protects against weather hazards such as rain, snow, and sleet. Characteristic of many designs is sloping top overhanging front and sometimes back of enclosure. Job requirements often necessitate adding bottom to keep out insects, snakes and rodents.

Type 4—Watertight. For indoor or outdoor applications where areas are cleaned by hosing down with water.

Type 5—Dust Tight. Protects control equipment where dust conditions are very severe.

Type 6—Submersible. Protects control equipment in areas subject to flooding. Specific conditions such as pressure and time of submersion must be considered.

Type 7—Hazardous Locations. Suitable for Class 1,

COMBUSTIBLE DUSTS such as aluminum, coal, grain, are kept out by this wall-mounted NEMA Type 9 enclosure for hazardous locations.

group D applications. Class 1 locations are those where inflammable gases or vapors are present in sufficient volume to be ignitable. Group D refers to specific gases such as gasoline, hexane, naphtha, benzine, butane, propane, alcohol, acetone, benzol, lacquer solvent vapors and natural gas.

Type 8–Hazardous Locations. Meets same requirements as Type 7 above. Electrical equipment in Type 8 enclosure is immersed in oil; in Type 7 enclosure it operates in air.

Type 9–Hazardous Locations. Meant for class 2 locations (combustible dust present). Group E atmospheres contain metal dust such as aluminum, magnesium, and commercial alloys. Group F atmospheres contain carbon black, coal or coke dust. Group G atmospheres contain flour, starch or grain dusts.

Type 10–Meets US Bureau of Mines requirements. Used in mines where flooding and explosive gases may be present.

Type 11–Acid and Fume Resistant. Suitable for indoor applications where equipment may be subject to corrosive acid or fumes of chemical plants, plating rooms, sewage plants, etc. Electrical apparatus is immersed in oil.

Type 12–Industrial Use. Often referred to as "oil tight" and JIC "automotive" type, both typical applications. Designed for industries where it is desired to exclude such materials as dust, lint, fibers and oil or coolant seepage.

STEEL CONSTRUCTION COMMON

The majority of enclosures for general usage are made of sheet steel. Arc and resistance welding are common, although a number are fabricated by bolting welded subassemblies together. Many small enclosures are of drawn-shell type.

Enclosures for oil-immersed equipment in hazardous locations are usually steel plates welded together. Enclosures for airbreak devices in hazardous location may be cast iron or sheet metal with porous vents.

Cast iron, stainless steel or aluminum are often used where corrosion is a problem. Stainless steel is good for control desk and operator station surfaces subject to wear from operators' hands.

The minimum thickness of steel for enclosures is set by several standards groups (see Table on next page). The size of the rectangular side or door determines the metal gage. Key dimension is max width of smallest side of rectangle. Where applicable standards differ, select thickest gage. Additional reinforcing, using formed sheet metal or rolled structural shapes, may be required if heavy transformers, starting reactors, or motor generator sets are housed in the enclosure.

WHAT SAFEGUARDS?

Numerous safety features are built into enclosures to reduce possibility of injury to personnel unfamiliar with electrical hazards, as well as to regular maintenance men. Some are:

- Key Locking–Cylinder locks and padlocks may be added to prevent meddling. One plan has three padlocks. During installation or while doing extensive servicing, the electrical maintenance supervisor, the mechanical maintenance supervisor, and the inspector each add a padlock. This prevents anyone from applying power while machine or electrical circuit is being worked on.
- Tool-operated Latches–A small tool such as screw driver, pliers, or wrench is required. It requires deliberate thought by a person to pick up tool and open door.
- Door Electrical Interlocks–Coil circuits of control are wired in series with door-operated electrical interlock. Should enclosure door be opened while equipment is energized, the contactors and relays will drop out, removing power. Door must be closed before equipment will operate.
- Door Mechanical Interlocking–The handle mechanisms for proper disconnecting devices such as switches and circuit breakers may be designed so the door on which they are located cannot be opened until power is removed. Where several enclosures are built as unit on same power circuit, all doors must be interlocked. Only way to gain access to any enclosure is to first shut power off externally. Then master door and the others may be opened.
- Isolation of High Voltage–Achieved by placing high-voltage elements into separate compartment designed into enclosure. Access may be with hinged door or by removing barrier.

ENCLOSURE TEMPERATURE

Housed electrical components give off heat which must be dissipated. If the enclosure is tightly sealed, total heat is removed from the surface by radiation and convection. However, if heat losses are great, louvres or screened openings must be provided for either natural or forced draft ventilation. Tests for each type are necessary to accurately establish capacity.

For a 90-inch-high enclosure with interior arrangement that permits free flow of air, a rough approximation of capacity (assuming 40 C rise in exit air) can be made by using following allowances:

0.1 w/sq in. for outside surface exposed to air

Minimum Wall Thickness of Standard Steel Enclosures

Based on rectangular sidepanel (max value of small side)

Panel size		Mfrs. Std. Gage (with nominal equiv., in., rounded off)			
			UL		
Side in.	Area sq in.	NEMA	Supporting frame No	Supporting frame Yes	JIC
5	....	24 (0.024)*	....	....	
7	....	22 (0.03)*	....	....	14 min.
10	....	20 (0.036)	....	....	
12	....	.....	20	24	14
14	....	18 (0.048)	....	....	....
18	....	.....	18	20	14
20	....	16 (0.06)	....	....	....
24	360	.....	16	18	14
28	....	14 (0.075)	....	....	....
40	....	12 (0.105)	....	....	....
48	1200	.....	14	16	14
56	....	10 (0.135)	....	....	....
60	1500	.....	12	16	12
	>1500	.....	10	16	10

* Min gage is 20 where conduit knockouts used

Outdoor enclosure . . . mounts on floor, meets NEMA Type 3 weather-resistant requirements. Function here is motor control, size is about 9x7x3 ft.

17.0 w/sq in. for free area of ventilation, with louvers placed at both top and bottom of door. Upper area should at least equal lower

10.0 w additional cooling per sq in. of free area of ventilation if opening is added to top of enclosure.

Forced ventilation may be required to avoid hot spots as well as to get sufficient over-all cooling. Resistors and other large heat sources should be kept away from heat-sensitive devices such as rectifiers and overload relays. Conversely, space heaters can prevent condensation if humidity is high. A psychometric chart can help determine necessary warming temperature and also estimate cooling per cu ft of ventilating air.

ENCLOSURE FINISHES

Iron and zinc phosphate undercoatings are widely used for good paint adherence and corrosion resistance. For higher resistance required in outdoor and highly corrosive atmospheres, red iron oxide or zinc chromate primer is often used. Either can be applied over the phosphate undercoat; zinc chromate is preferred and has widest acceptance. It has excellent resistance to chlorides, including common salt, sulphates, and other corrosive atmospheres—and is accepted by the Navy.

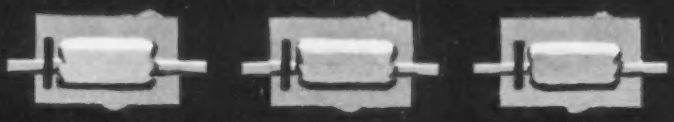
Lacquer, air-dry enamel, and baked enamel are used for finish coats. Lacquers have advantage of drying fast, but have low corrosion resistance for outdoor applications. Synthetic enamels are preferred because of higher corrosion and abrasion resistance. Baked enamel is preferred over air-dried type since it has reached optimum quality by end of baking cycle. Air-dry type, although dry to touch, does not reach optimum quality for several days or longer.

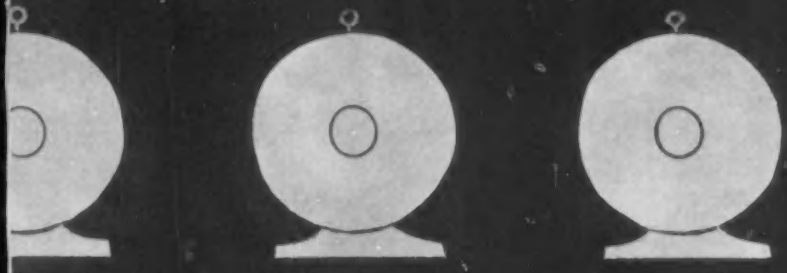
REPRINT of this article can be obtained for your reference file by checking No. E29 on one of the Reader Service cards inside back cover. For other reprints available see "Current Reprints" listing in this issue on page 153.

EDITOR'S NOTE: "New look" in motor-starter enclosures is described in "Magnetic Motor Starters are 42% Smaller," Aug '57, p 220; and "New NEMA Standards for Motor Starters Reduce Cost and Space," June '57, p 189.

Help in designing enclosures is given in several previous articles: "Thermal Radiation from Hot Surfaces," Mar 31 '58, p 116, plots radiation in btu/sqft/sec vs temperature for many emissivities; "Pre-painted Steels," Dec 9 '57, p 99, offers money-saving ideas in metal protection; and "Gasketed Joints for Electrical Equipment," Mar '57, p 183, pictures most gasketing methods and includes selection chart.

DESIGN FOR AUTOMATIC PRODUCTION





AUTOMATIC MANUFACTURE FOR HIGH PRODUCTION . . .

by Clifford L. Johnson, Director of Production Engineering, AC Sparkplug Division, General Motors Corporation, Flint, Mich.

The design problems for components in high production — automatic assembly of sparkplugs.

AUTOMATION CONQUERS AN ARDUOUS TASK . . .

by R. O. Vuilleumier, Technical Director, General Engineering Laboratories, American Machine & Foundry Company, Greenwich, Conn.

A case history in precise manufacture in moderate volume for an instrument servo.

AUTOMATING A LARGE LOW VOLUME PRODUCT . . .

by Fred Baumann, Manager of Advanced Engineering for the Small A-C Motor and Generator Department, General Electric Co., Schenectady

How automatic manufacture was developed for low volume, heavy and complex electric motors.

Automatic manufacture is stepping out into a broader field. The principles of "automation" still apply — mechanical hands doing the work. But they no longer need be confined to long assembly lines and mass-production output — automatic manufacture can also produce moderate or even small quantities.

This step forward becomes entirely possible when the product — and the machine to make it — are designed together. It is this coordinated approach that is behind success of the three case histories presented here, based on papers presented at a session on "Design for Automation" at the 4th International Automation Congress two weeks ago.

Whether for small or large production quantities, the automatic way is born from the urge to add greater value — more performance at less cost — by freeing production and assembly operations from the limitations of human muscle, dexterity and skill.

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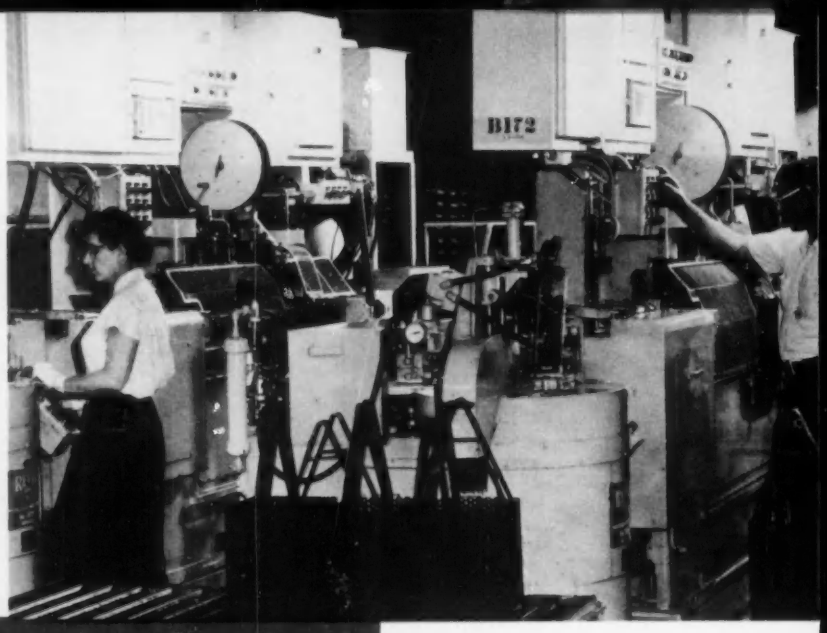
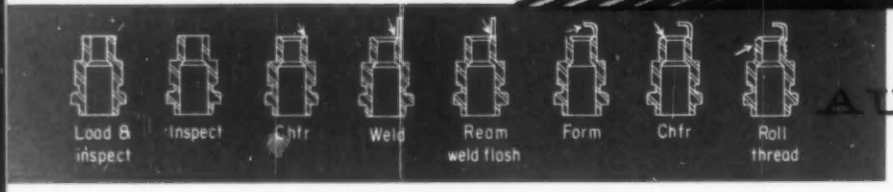
DESIGN FOR AUTOMATIC PRODUCTION

SPARK PLUG BODIES...

are automatically manufactured by a battery of these machines, (A) before moving on for automatic assembly of the complete plug. The body and the machine that makes it, shown in closeup view (B) were designed together. From automatic hopper feed of a screw machine shell, successive stages (C) inspect, chamfer, weld wire, ream weld flash, form wire, chamfer, and roll thread.





Rolled threads instead of chased ones are faster, eliminate chips, and increase strength of the threaded section—but primary consideration was easier adaptability to automatic operation. The roll-threading cycle balances rate of other operations—a machined thread would have reduced production rate of the machine.

AUTOMATIC HIGH

Just building something need not worry us. If you can design it, you can almost surely build it – whether the method is practical or not. The key word is *feasibility*. And to determine feasibility you need real liaison – the kind that brings in considerations of cost, product engineering, purchasing, quality control, tooling, manufacturing, sales and others. Too often, for example, the pressure of getting into production introduces problems, particularly in the automotive industry. But integrated manufacturing, with liaison providing proper organization behind it, can do a pretty fair job of reducing cost.

In designing for integrated manufacture, the most important aspects include costs of tooling and the facilities required. Also, huge banks of material in process can no longer be tolerated. Processes must be integrated from beginning to end with ingenious methods of manufacture. In the automotive and related high-production fields we have done a great deal in designing products for automatic assembly. Let's look at the points of prime interest.

Simplify the design. This can be done only by coordination between product engineering and tool engineering, if the product is to be manufactured with the least expenditure for tools and equipment. Survey meetings held with planning groups representing cost, tooling, product design, manufacturing, inspection and sales will unify the program to reduce parts cost and simplify design. But the primary responsibility rests with the product designer; he must know what is needed, and find the simplest design means of fabricating or assembly. This requires considerable experience in both the design field and in manufacturing.

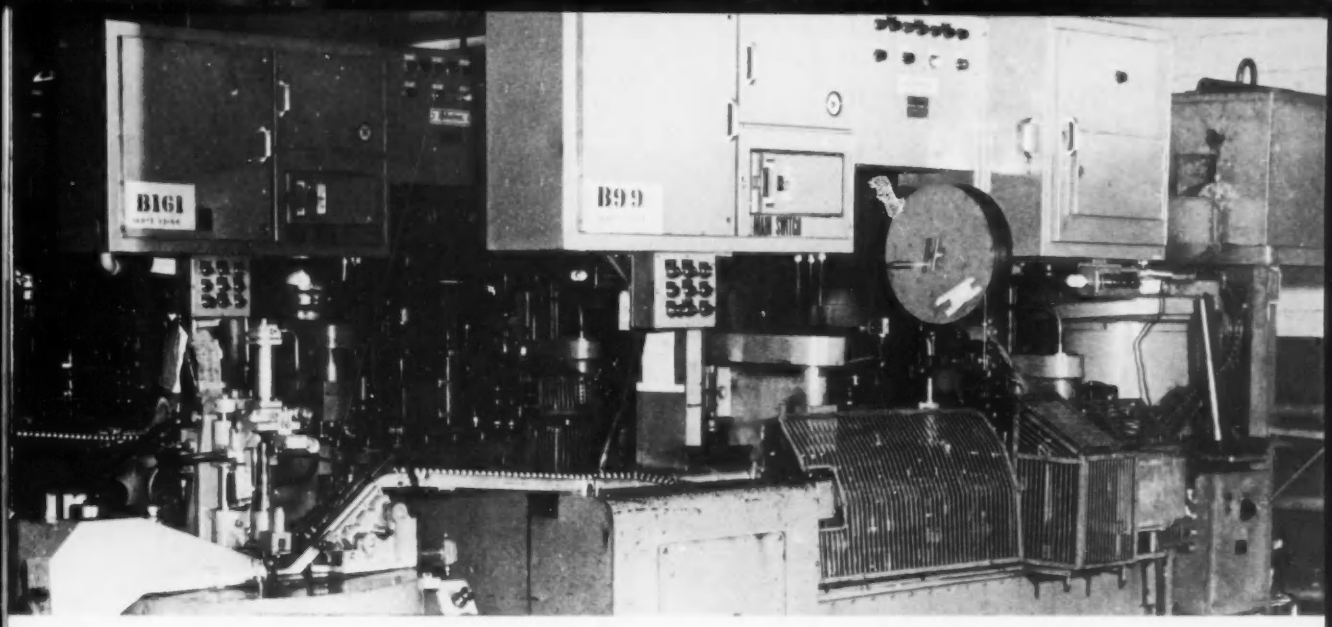
Simplification of design does not always call for fewer parts. In a particular assembly an extra part that results in lower tool costs may make for lower final cost. For example, integral brackets are possible in automobile body assemblies but at such added expense in progressive dies that the one-piece design costs more. It may also be less expensive to divide a die casting into two parts, and avoid the cost of intricate core pullers for sliding members of the die.

Use standard parts. Outside sources often can supply a suitable part, already in production, which can be purchased without tool cost. Sometimes, parts may be made from slugs or scrap from some punch press operation on another part. Shoe heel stock can still be purchased as

Clifford L. Johnson, Director,
PRODUCTION ENGINEERING
AC SPARK PLUG DIVISION
GENERAL MOTORS CORP.

ABOUT THE AUTHOR

Cliff Johnson has been involved in problems of integrated assembly for more than 20 years—on the production side—ever since graduation from General Motors Institute. Today, as Director of Production Engineering of AC Spark Plug Division, he is responsible for preparing some 30 major types of automotive accessories for automatic manufacture—spark-plugs, oil filters, instruments, air cleaners, etc.—at production levels counted in the millions.



MANUFACTURE FOR PRODUCTION

screen material from shoe manufacturers. Commercially available parts can often replace some of the off-standard designs a young engineer may conceive.

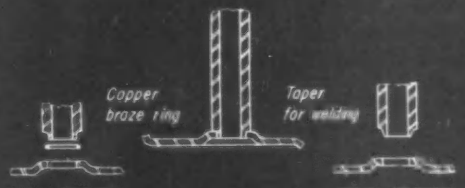
Use ample radii and fillets. Tracks used in feeding parts to an automatic machine can then have rounded corners, which trap less dirt and are less subject to failure during heat treatment. When radii or fillets are permissible, tumbling or blasting will often solve deburring problems. Fillets increase the strength of castings; sharp corners can make it difficult to eject die castings.

Power tools. For automatically driving studs, screws and nuts, a straight-drive approach is far more economical than being forced by interference to drive at an angle. Replacement costs of universal joints and right-angle drivers are prohibitive. Also, clearance between bolt heads and nuts should be sufficient to permit use of multiple drivers.

Hopper feeding. In any integrated automatic process, component parts must be fed into location on time and in the proper position. This is probably the most important requirement of all, and requires the utmost consideration in parts design. The simplest way to feed a gasket into a cavity often is to pierce, index and then blank straight through the die into position into the part. Gasket material must be sufficiently stiff to avoid distortion, and scrap must be fed out of the die.

Hopper feeders have to orient the parts before transferring them into the track. Feeding can be simplified and die cost reduced if a part can be made symmetrical and installed from either side. Parts can often be oriented by balance if they can be channeled to fall away when positioned improperly. This offers a good opportunity if the

REDESIGN FOR EASIER AUTOMATIC ASSEMBLY



OLD DESIGN

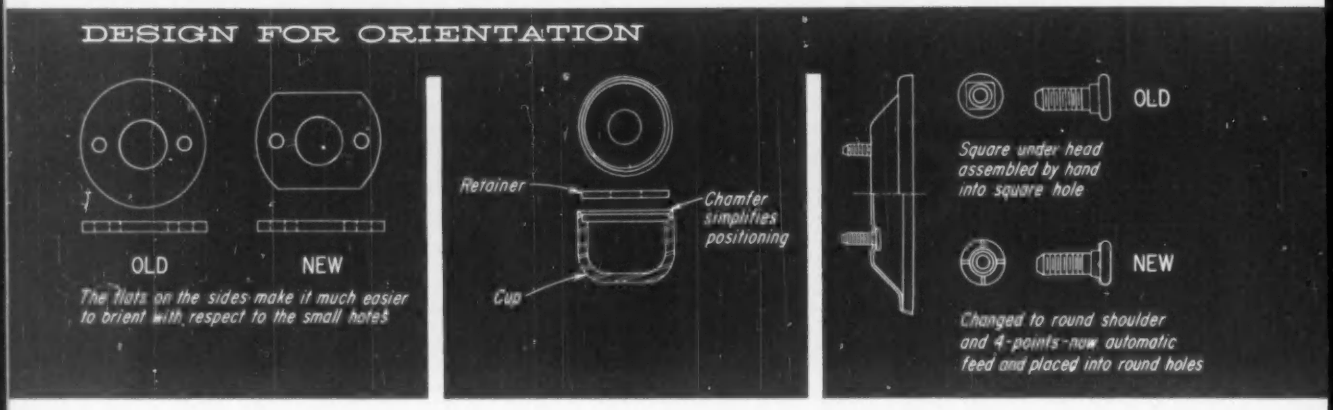
1. Press fit assembly close tolerances
2. Copper braze
3. Straighten to remove distortion

NEW DESIGN

1. Slip fit - wider tolerances
2. Weld - no distortion

OLD	NEW
1. Pinion slip fit into gear and staked. Build-up of tolerances resulted in eccentric assemblies.	1. Gear press fit over tapered pinion hub. Hub staked. Eccentric assemblies eliminated.

OLD	NEW
1. Worm slip fit on shaft 2. Set screw driven into tapped hole in worm	1. Worm pressed on knurled shaft


DESIGN FOR ORIENTATION
OLD
NEW
The flats on the sides make it much easier to orient with respect to the small holes
Retainer
Chamfer simplifies positioning
Cup
OLD
Square under head assembled by hand into square hole
NEW
Changed to round shoulder and 4-points-now automatic feed and placed into round holes

part is long, such as a special bolt or bar, or a long, cylindrical part of irregular shape.

Material selection for safety. Avoid materials of a toxic nature, or with a low flash point. Flame-proofing can be applied at reasonable cost in many cases where inflammable materials must be used.

Simple fasteners. Threaded connections can often be replaced by new and simple fasteners. A standard case-hardened screw pressed into a cast hole in a diecasting can eliminate a tapping operation. Hopper-fed nuts are being used to pierce their own hole in progressive dies and are then staked into position. But welding is generally the least expensive and the simplest, and should always receive first consideration.

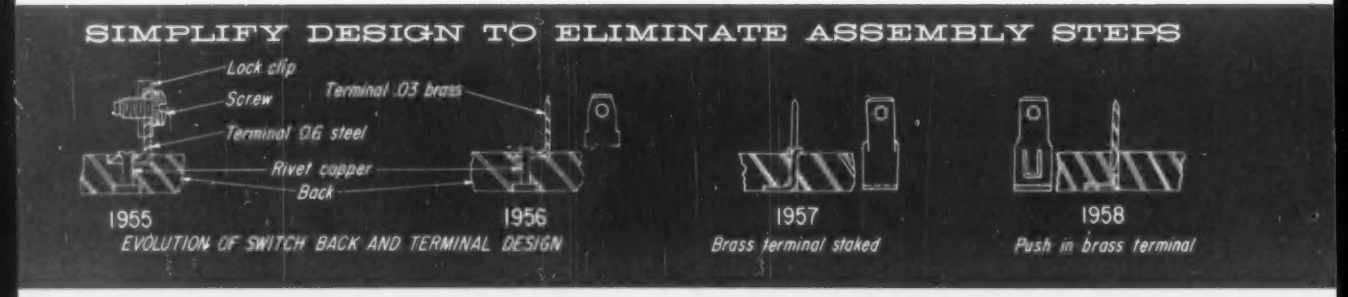
Fasteners that can be pushed into a position and staked or riveted, are better than those that must be twisted or turned. Eyelets can be produced on simple equipment adjacent to the assembly machine and integrated with the assembly. Where the equipment does not have to be disassembled in the field, rivets and clips are better than screws or bolts. The number of fasteners used should be only what is necessary to hold the parts together securely.

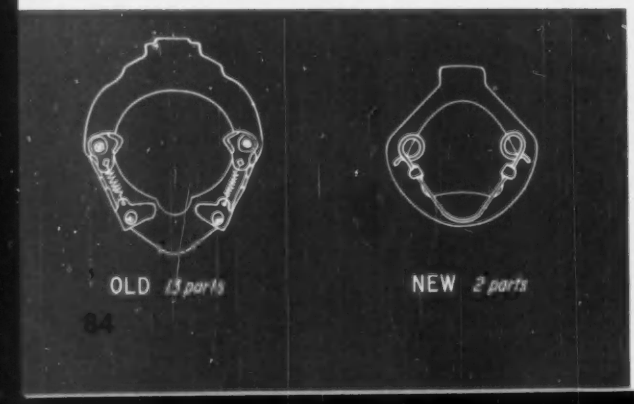
DESIGN FOR MECHANIZED ASSEMBLY

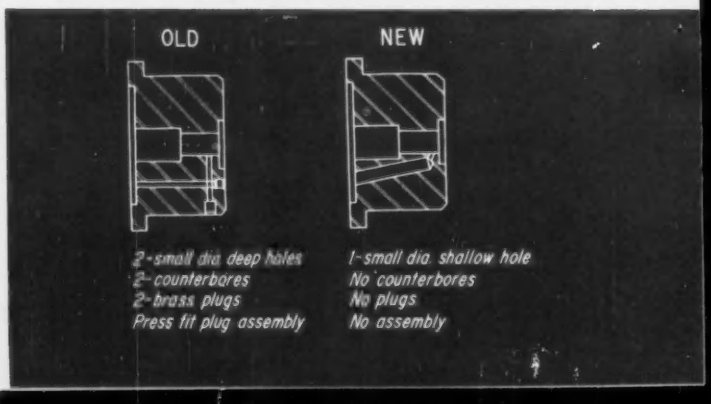
Where hopper or mechanical feeding is employed, track dimensions and escapement problems usually make it necessary to hold parts to closer limits. This is to prevent expensive downtime. In commercial screws and bolts, scrap of 1 to 2% is common. Automatic sorting devices ahead of the hopper can eliminate the scrap and reduce downtime.

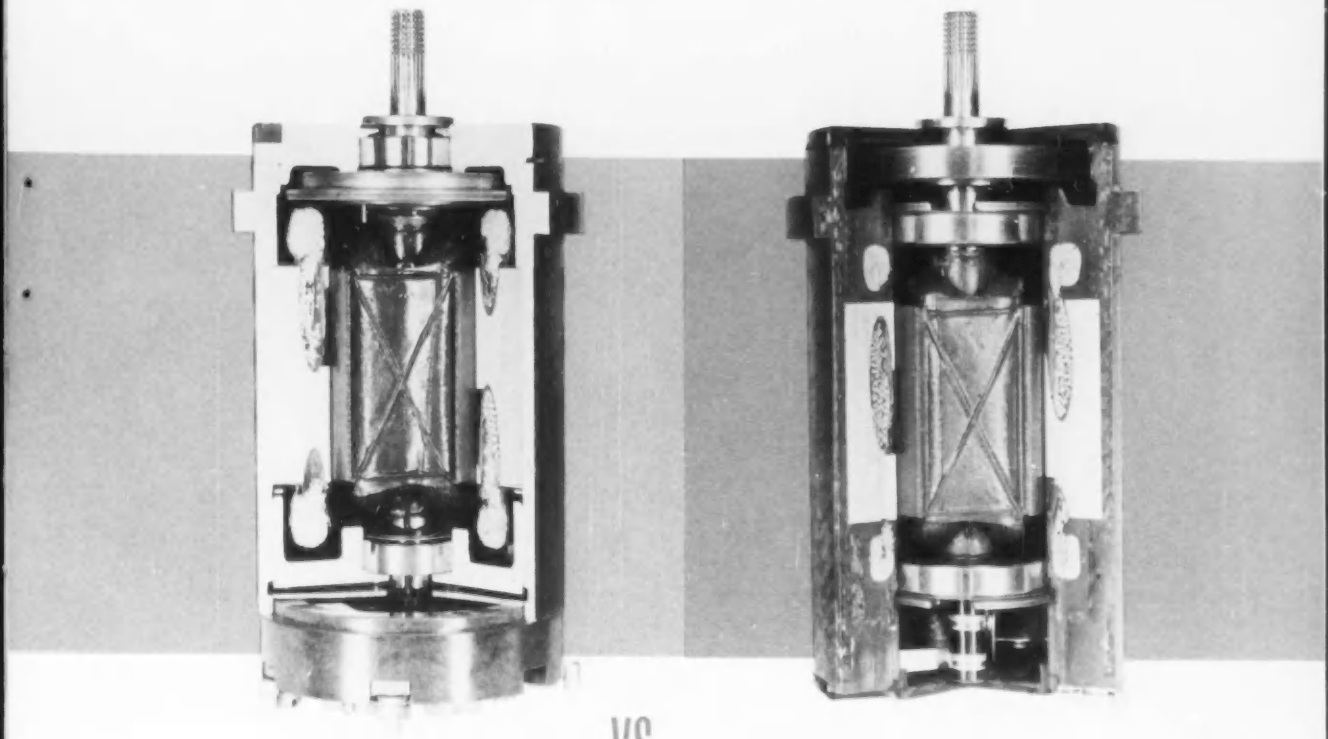
Notches are much easier to locate than pierced holes. Fasteners should be driven from one side to avoid turning the part over. Parts should be designed to permit plating after assembly; this avoids breaking up the sequence of an integrated process. When wires and cables are used in the assembly, they must be protected from damage during subsequent assembly operations.

It is becoming increasingly important that handling equipment be flexible in design. The cost of the part you make can be affected greatly if a change can be accommodated by existing equipment.









HAND VS MACHINE...

Old method of servo construction, left, permitted cumulative buildup of tolerances to affect airgap. Design for automatic manufacture, right, substituted a plastic housing and a machine-wound stator, with no change in outside configuration.

AUTOMATION CONQUERS AN ARDUOUS TASK

How automatic manufacture not only replaced skilled hand operations in making an instrument servo, but gave a more acceptable product.

R. O. Vuilleumier, Technical Director
GENERAL ENGINEERING LABORATORIES
AMERICAN MACHINE AND FOUNDRY COMPANY
GREENWICH, CONN.

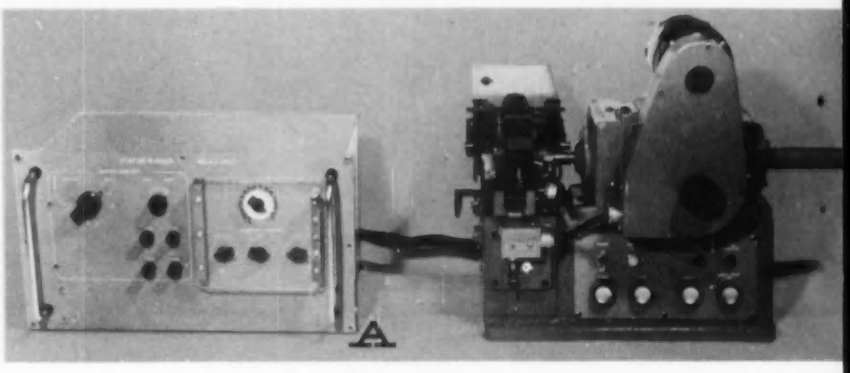
ABOUT THE AUTHOR

Mr. Vuilleumier directs a staff of 29 engineers and technicians who serve as consultants to the entire laboratory staff at AMF's General Engineering Laboratory, Greenwich, Conn. His background includes several years of design engineering and 14 years in the Mechanical Engineering Dept. at Stevens Institute of Technology, where he carried on an active consulting program with clients including AMF. He joined the company in 1955 and became Technical Director in 1957. Most of his projects have concerned development of automatic process machinery as well as radar, ordnance and missile hardware.

The electrical synchro is a modern measuring tool that translates rotational displacement into electrical signals. It follows complex motions to assure they are performed in the proper sequence... at the correct time... with exactness. Its method is to compare actual behavior against planned behavior, then signal the difference or error. Obviously it must be accurate itself – many military applications and some commercial ones require accuracy to within 6' of arc.

Besides these critical requirements for precision, commercial applications demand lower cost and better per-

AUTOMATIC WINDER...



for stator coils is teamed (A) with control unit which sets operating speed, counts turns, indexes stator. Winder inserts a predetermined number of turns in each of 15 slots, pulls out leads as needed, and stops when winding is done (B). Closeup view (C) of winding arbor, nozzle and shoe shows where wire is inserted. Slot insulation is shaped to spring back and retain the wire after the nozzle passes. An arm on rotary solenoid in foreground forms loops (D) for leads.

formance. Two major problems in meeting these needs arise from variables – in hand labor when winding stators and in satisfactory performance under extreme operating conditions. The Navy Department and other military groups have supported a production improvement program to meet these needs, and Navy's Bureau of Ordnance contracted with AMF for a dual program: to eliminate the hand labor in the manufacture of synchro stators and to develop a plastic enclosure. The size 23 synchro of instrument accuracy selected for the program has a stator about 1 in. ID and coils of 90 turns each in 15 skewed slots.

Although machine methods have been used on stators for larger motors, hand methods have been traditional for these small sizes. Girls were trained to insert series-connected machine-wound coils into the preinsulated stator slots. The operation required considerable skill developed only over a long training period. Production was low – about two per hour per operator. The wound stators were then inserted in a metal housing with the rotor, bearings and slip rings. Finally, the synchro was given its electrical accuracy test. Rejects ran as high as 30%. While some could be reworked the salvage was low.

THE TROUBLE WITH SPECIFICATIONS

It was apparent in early stages of AMF's program that mechanical specifications for the synchro could not be stated in sufficient detail to satisfy the electrical accuracies desired. We could define thickness of slot insulation, number of turns and resistance of each coil, mechanical tolerances of the laminations and of the completed synchro, and many other mechanical aspects of the assembly. But even if these were satisfied, there was no assurance that we would get the required electrical accuracy, or that the minor changes in design required by automation of the process would not have adverse effects on accuracy. For these reasons, it was decided to jury-rig the entire process to provide a standard for performance and to produce test stators as rapidly as possible.

The other portion of this dual development program concerned redesign of the synchro assembly to utilize plastic construction. Why plastic? A complete plastic encasing would withstand adverse operating conditions, vibration and shock, and atmospheric exposure.

Final goal was a small manufacturing pilot line in which only the major elements of the mechanical equipment were to be developed. Hand operations were still acceptable at this point wherever known techniques could be applied later to make the line automatic.

ELEMENTS OF REDESIGN

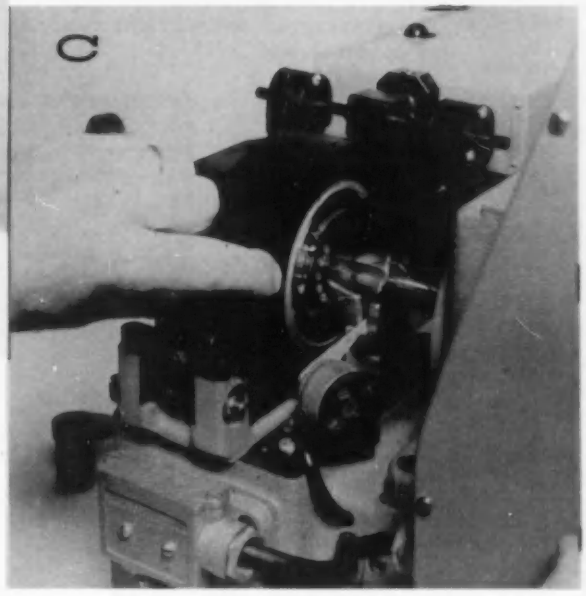
In redesigning the synchro, basic configuration and construction of the stator and rotor could not be altered; changes in only the outer case bearings and slip ring assembly could be considered. Here again it was necessary to resort to jury rigging as rapidly as possible so a final product could be available for electrical test.

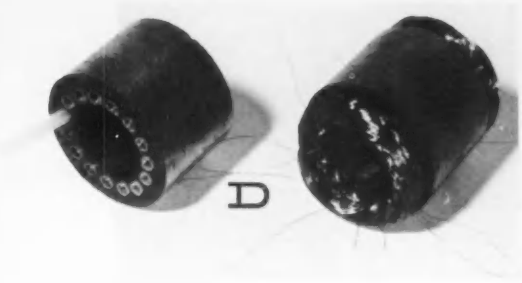
The many problems associated with plastic construction could not be evaluated as to their effects on synchro accuracy until a prototype was available for electrical test. Other problems in this phase of the program were selection of plastic formulation, configuration and types of reinforcing material, and behavior of the complete synchro under environmental conditions of temperature, vibration, and shock.

FEWER CLOSE TOLERANCES

Externally, the new plastic-housed design looks the same as the former metal-house configuration, but the internal construction is simplified, as shown in the comparison of cutaway views on preceding page. Alignment of the rotor with the stator is critical, and for the metal-housed synchro, four matching diameters on the case had to be held to close tolerances to hold the airgap constant. The tolerances on these diameters were in series and could add up to serious inaccuracies.

In the new plastic-housed synchro the internal diameter is the only critical one. The rotor bearings are matched to this and can be held in close alignment with the interior bore of the stator. It is now impossible to develop a serious buildup in tolerances.





HOW COILS GO IN

Stator winding was mechanized by a machine that automatically inserts coils into a slot, one turn at a time. This method was designed to act also as a trap for the wire. A guide nozzle opens the slit in the insulation as it deposits the wire; then the insulation springs back into position to prevent the wire from slipping out of the slot. Each coil passes through two slots spaced approximately 144° apart. Each slot, therefore, carries opposite legs of two individual coils, making a total of 180 strands of #33 AWG wire. Wire loops projecting from the coil are picked off automatically during winding to form the leads.

The amount of wire that appears at each end of the stator core was a critical problem in developing the automatic winding method. Length of this wire had to be kept to a minimum to keep the coil resistance at required value and to avoid increasing over-all length of the completed synchro. The compacted mass that this wire formed as the stator was being wound acted as a serious interference to operation of the winding machine. Considerable design effort and jury-rigging time was necessary to overcome this handicap.

THE TEST APPROACH

Several basic principles common to the design of automation equipment are illustrated by our experiences on this project. Analysis by calculation has limited usefulness in developing machines for automatic manufacture. While broad areas of approach can be narrowed by analytical treatment to general statements of feasibility, detailed success is assured only by jury rigging and experimentation. This is particularly true where electrical performance of the final product depends on a complex arrangement of mechanical functions and accuracies that cannot be clearly defined in advance.

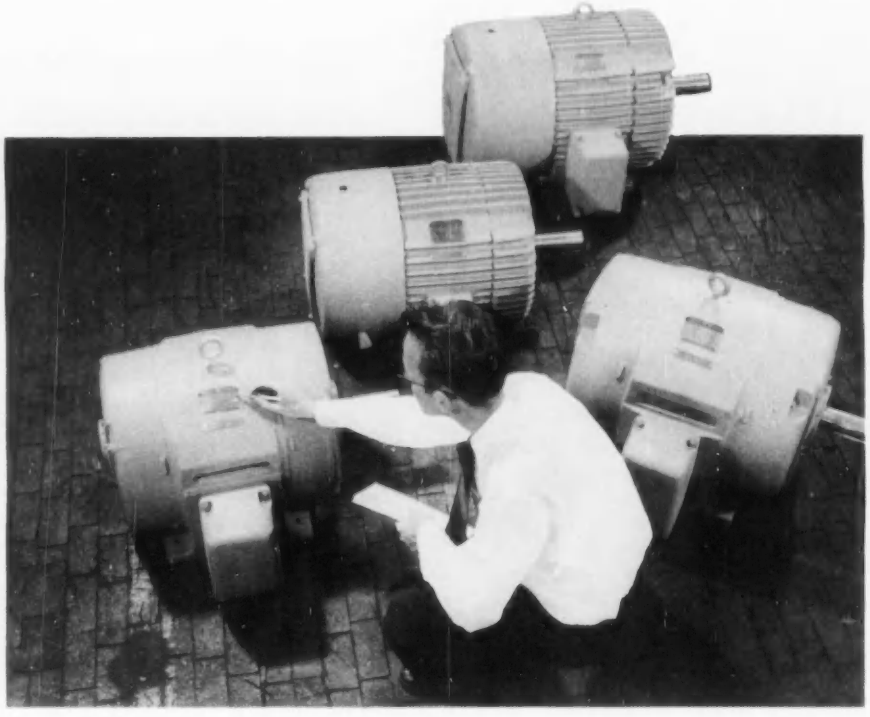
In developing an automatic machine, it can often be seen at the start that hand operations will not be profitably translated to machine motions. This is why complete analysis of the basic requirements should be made first. They will serve to define the machine functions needed to produce the desired operations. Then follows selection of the proper mechanical or electrical device to do the job.

Selection requires considerable care to prevent introducing undesirable or unnecessary functions which often lead to inefficient compromises. Quite often it is impossible to anticipate these extra features; they are only discovered by experimentation. As an example, in the servo winding machine we found that the wire insulation was damaged during winding. This was tracked down only after considerable experimentation and a substitution of materials.

SOME GUIDE POSTS

When basic design changes in the product cannot be made, the conversion to automatic manufacture may necessitate many new functional parts. Also, the machine may not duplicate the hand function in its entirety. Quite often the handling sequence is different and requires parts of the product, while still retaining their basic design function, to perform some of the manufacturing operation themselves — a job quite different from their operational function in the product. For example, the slot liners in the stator retain the wire in the slot as the coils are wound.

These are some of the general guide posts we encountered during our design for automatic manufacture on this project. They are characteristic of a number of other projects we have undertaken, such as cigar and cigaret machines, the Pinspotter, bread slicers and wrappers, and an automatic machine for making transformers. These basic principles have universal application to the automatic manufacture of almost any product.



AUTOMATING A LARGE, LOW-VOLUME PRODUCT

It's a formidably big hunk of machinery . . . it's produced in comparatively small quantity . . . yet it must appear in a variety of models scattered all over the lot. Just how can you automate such a challenging situation?

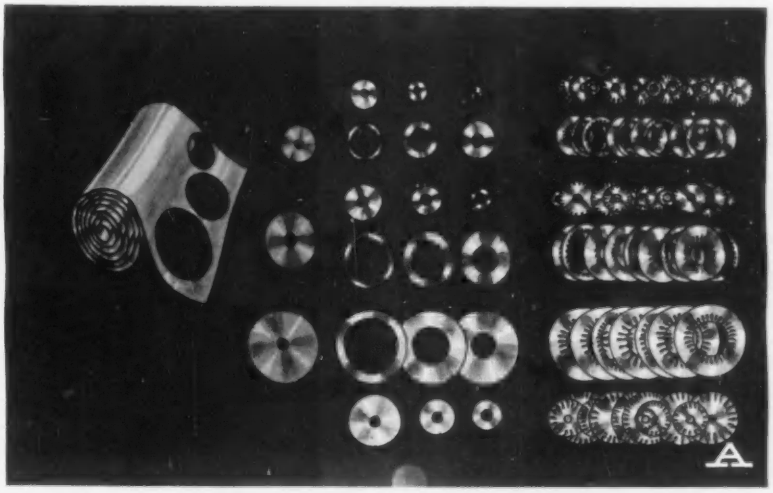
Fred Baumann,
Manager of Advanced Engineering
SMALL A-C MOTOR AND GENERATOR DEPARTMENT
GENERAL ELECTRIC CO., SCHENECTADY

ABOUT THE AUTHOR

Because he had successfully carried out GE's redesign program on the 7½-to-30 hp motor line, it was natural that Fred Baumann should be selected to head up the redesign program on the 40-to-125 hp line. He is a product of University of Minnesota, MIT and GE's own Advanced Engineering Program. His several years of increasing design responsibility at GE led to his becoming Manager of Product Engineering and Director of the Task Force for the Tri-Clad "55" line set up in 1950. His next assignment was the one described here.

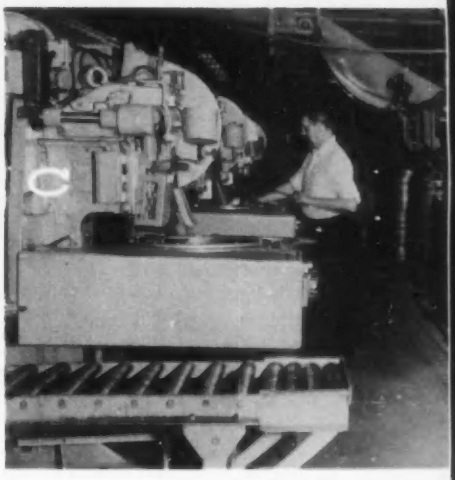
Let's face it. Automatic manufacture turns out standardized products. But how do you standardize the standardizer when the product is a large one, output is to be relatively small, and a wide variety of models are needed?

My answer is taken from a case history at General Electric – the time when our Small AC Motor & Generator Department redesigned its larger Tri-Clad 55[®] motors, and also the facilities for producing them. Of course, a particular set of circumstances was involved. But our experience can give a starter when you are thinking out a similar problem.



SIMPLIFICATION DOES IT...

All motors are made from three fixed-OD "cookies" (A), each made into three different lamination blanks by varying the ID. Inside scrap forms blanks for rotor laminations. Slotting is varied to



produce hundreds of different sizes and shapes, all from the initial three cookies.

The three sizes chosen became the standard for all materials handling and layout – this inflexibility was deliberately designed in to maintain standard dimensions for a long period of time.

Slots are produced by two methods, depending on activity. For a few used repetitively, multiple-slot tooling was built; for the rest slots were cut one-at-a-time on an indexing setup. This meant built-in inflexibility for high-volume parts and extreme flexibility for low volume.

Magnetic belts (B) carry rotor and stator blanks from punch press; waste goes under floor to scrap loaders.

Stored blanks come in on overhead conveyors (C) to stocking spindles, and are fed manually to indexing machines.

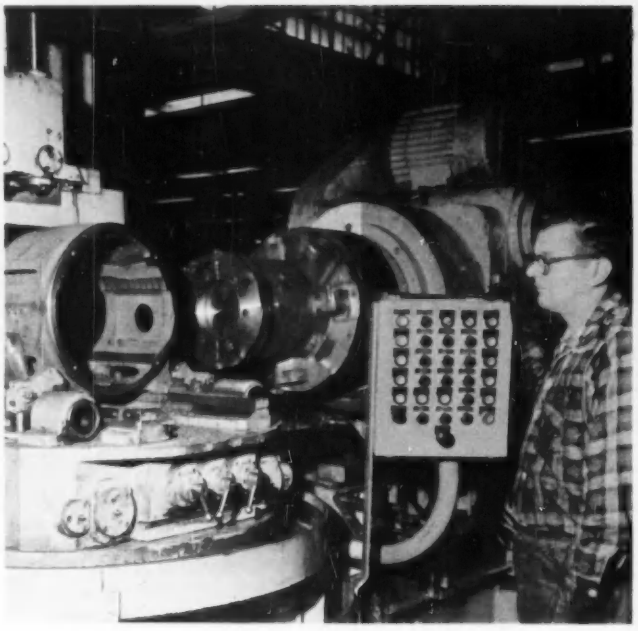
In 1953, General Electric found itself with a motor line, 40 to 125 hp, that was over 13 years old—and out of date. The smaller line, 7½ to 30 hp, had been redesigned and announced that year, and NEMA was recommending new standards for larger motors. It was obvious that a complete redesign of the motor line was necessary.

This was the challenge put to both product and facilities designers: "Design a smaller, lighter, better performing motor – and produce it economically."

Furthermore, facilities for turning out the existing motor were way out of date—they couldn't possibly keep

THE RULE OF 3 . . .

governs built-in inflexibility here too.
Semi-automatic cutting, boring, drilling and tapping machine takes any one of three different-size frames, adjusts itself automatically to the proper size, and completes the machine operations—while attendant maintains hands-off policy.



TASK FORCE IS BORN

First step in our approach was a very basic one: a "Task Force" was organized, made up of men from product design, manufacturing, engineering, production, marketing, and finance functions. Their job was to set the standards for the new product to fit the requirements of automation—and yet allow freedom to respond to constantly changing conditions. They were to investigate all possibilities and recommend the best to management. This organization allowed "cross breeding" of ideas which gave the most workable number of alternatives and choices in a reasonably short time. It did not leave a stone unturned in thoroughly covering all possible solutions.

This carefulness is especially valuable when products are to be turned out in low volume and a wide variety of models. In many such situations the choice is between job shop or automation. With low volume you can't make yearly changes. A thorough, long-range look must be taken each time a design is changed. Many times, compromises must be made for the sake of flexibility.

THE OPEN MIND

Well, the Task Force took a look at the desired product. It explored surveys reporting the needs and requirements of customers and salesmen. It scrutinized new standards recommended by NEMA. It investigated all new insulating materials, metals, and design innovations.

All this had to be an open-minded, objective analysis. The men freed-up their minds, tried to overlook any preconceived ideas or personal likes and dislikes. For example, the material for motor frames was finally narrowed down to castiron, sheet steel, or cast aluminum. But which was to win? The decision was all the more important because it would set a pattern for the rest of the design. The group went ahead on such material and prepared detailed reports—from all angles. Cast iron won.

PUTTING ON THE SQUEEZE

Then came reduction of the number of different component parts needed for the entire motor line. It's necessary to get repetitive value from a given part and squeeze as much use out of it as possible. Job shop people have the same problems, of course, but it's obvious their setup problem is not nearly as acute. When you go into special-purpose machinery and automation, you should get enough volume limited in variety—or you'll fall all over yourself on setup time.

The shrinkage technique was also applied to the number of different models that would be produced. Some were combined into one modification; others were eliminated entirely.

While the Task Force was changing the motor, the manufacturing engineering people—aided by marketing forecasts and cost analysis—laid out the facilities. A wide-open, free exchange of information and ideas went on all the time. It gave an excellent, coordinated manufacturing plan.

SOLUTION FOR SPECIAL MODELS

First they found the production of special motors would be higher than standard motors in a 60% to 40% ratio. Therefore, we would have wide variety at low volume.

Combined with this mix, the expected volume did not justify separate production lines for specials and standards as had been possible in the 7½-30 factory. But use of only one line would cause a slowdown of standard motors while waiting for special work to be done.

The answer was to have separate, special process areas running parallel to standard areas wherever specials would slow down the production cycle. Specials would be detoured into their own little areas along the line. The

PUNCHED TAPE . . . tells the coil-winding machine what to do. The operator merely selects the tape and attaches wire to be coiled. Machine then automatically winds the proper number of turns in the prescribed shape — with no operator error.

plan worked and production flow now looks somewhat like a straight line with a series of football shapes at different spots.

As the facilities plan grew, materials handling problems were overcome too. With weights up to 5000 lb., and work on motors performed in two separate, and separated buildings, this one looked tough at first. But it worked out.

LOGISTICS OF ASSEMBLY

All machining is done in one building, and subassemblies and final assemblies in another. The parts are machined to forecasts and economical quantities are then stocked. An overhead conveyor then takes machined parts, as needed – moves them outdoors, around the building, and into assembly points in the other building. This separation also keeps cast-iron dust out of assemblies.

Even though production volume is relatively low, the major expense in this factory, and the greatest effect on shipment cycle, comes from materials handling. Using a variety of forktrucks, hand trucks, dollies, etc., would cause terrific congestion, and be subject to the whims of nature for delivery. Solution was to have one vendor sell us and install the materials handling equipment. This one-source method, plus a coordinated plan, gave the greatest flexibility for minor changes, since using standard conveyor and roller parts make re-arrangement simpler. Of course, this phase could have been handled by the manufacturing people. It depends on experience of the personnel and the time they have available to work with materials handling.

The Task Force was now able to complete its job. It presented management with the major alternatives for the product, manufacturing equipment, materials handling and production systems – with detailed reports on each, and a recommendation. The choices were made. And they were carried out.

IT'S ON THE RECORD

The Task Force provided a very valuable side benefit. Everything – but everything – was documented. And this proved extremely valuable. After several years people forget the ground rules and objectives used in such a project. Properly recording the studies of different alternatives, and reasons for the decisions, gives factual historical background to answer questions from people who don't remember, or weren't there. It gives good background when any further investigation goes on. And it prevents a lot of wasted energy in going over everything again. You can go back to see what has changed – and why – whenever new tools and materials give you a valuable new idea. Documentation is extremely important in the first phase of a design project.

When you automate for low-volume production, take a long, careful look into the future. Wherever a branching occurs, make sure each available path gets careful scrutiny. Compromise is necessary, of course, and will create some measure of inflexibility. However, keep flexibility where it is needed, now or in the future.

WHERE PEOPLE COUNT

One important point about automation: Don't put all your faith in the machine. Take a walk through your plant sometime when it's empty and quiet. If you thought it was impressive before, you'll see that this isn't the case when machines are still and posts deserted.

No machine tool is impressive . . . no factory is impressive. What stands out is the skill and talent of the designers who bring such things into being – people whose job it is to combine men, machines and materials to meet the dynamic hunger of the world for more goods and services.

BACKGROUND READING

This issue's articles on the three aspects of design for automatic manufacture come to readers already alerted to growing importance of this field. There is design in Product Engineering's editorial program too. It aims at furnishing a continuity of information—technical data and background for decision.

PLANNING FOR AUTOMATIC MANUFACTURE

How the interests of marketing, R & D, production and management are coordinated in designing products and the machines to make them.

"How You Can Buy Time," Apr 7 '58, p 32. A technique used at the AC Spark Plug plant in Milwaukee to coordinate the steps of R & D, product design, and manufacturing tooling to get a new product on the market faster.

"The Case for Process Engineering," Mar 31 '58, p 118. What to do when production know-how falls behind design and marketing practices.

"Best Setup for R & D," Oct 21 '57, p 34. How project and service organization can be combined with advantage when the policy is to make the customer the boss.

"Mechanical Assembly Equipment," Mid-Oct '57, p A16. Primary problems are economic rather than mechanical; best manual approach measured against mechanized; unit savings for anticipated volume; effect of time required to get equipment in operation, and anticipated model changes.

"Economical Lot-size for Manufacture," Mid-Oct '57, p A2. Nomograph for determining economic lot size includes setup cost, carrying charge, unit cost and monthly production.

"Models Show How . . . ," Sept 16 '57, p 99. When a number of men, many not engineers, are involved in product decisions, models are often the one best way to keep everyone thinking straight. Types of models, where they come from, and outstanding examples—in full color.

"Committee Engineers Profit Into Price," May '57, p 144. An on-the-spot report of the setup at Westinghouse in East Springfield, Mass., and how it works to bring all elements to bear on engineering profit into design—including decisions on automatic manufacture.

"Pre-production Engineering by Committee," May '57, p 150. How Emerson organizes skills for the optimum in automatic assembly, and gets all changes made before production starts; makeup and functions of the manufacturing-engineering committee responsible for designing the product and the equipment to make it.

"The Administrative Engineer Can Help," Apr '57, p 190. In supplying planning and control, the administrative engineer can function as a coordinator of research, design and management, and interpret technical matters in nontechnical language.

"Man Is a Machine Component," Dec 30 '57, p 34. A 4-step analysis of man-machine relationships as a guide to effectively employing man as a link in the machine system.

"Project Group vs Service Group in Engineering Development," Aug '56, p 198. Contrast of two methods; influence of size of company, type of management, and significance of morale. Enthusiastic leadership is held to be the key element.

"Product Development—the Project Engineer's Place," Dec '55, p 189. Inclusive chart of steps in product development to guide in conducting an effective project; function of the administrator.

"Engineering Problems in Continuous Automated Production," Mid-Oct '55, p A2. Influence of type of machine, tool design, control system, maintenance and investment; economic lot size dependent on characteristic of part. Three classes of automatic machines; problems of storage, demand, control, positioning, checking; down-time limitations. Includes abstracts from 17 articles and technical papers.

"Product Development Conference," Oct '55, p 129. Excerpts from a 3-hr recorded conference of the management committee responsible for product development at Yale & Towne. Solving communication problems; function of a coordinating engineer, and need for effective cooperation between specialist groups.

"Break-even Charts Tell You if a Product Should Be Made," Mid-Oct '54, p A25. How to determine profit and break-even point; aid in selecting alternative manufacturing methods; extent of mechanization.

ADVANCES IN AUTOMATIC EQUIPMENT

Some recent examples of the application of principles of automatic manufacture in new fields:

"Now—a Tape-controlled Production Line," Mar 24 '58, p 28; Mar 31 '58, p 40. Automatic electronic control applied to a series of machine tools at Hughes Aircraft.

"Mechanization in Mail Sorting," May 12 '58, p 22. Description of equipment, coding method and electro-mechanical sorting system at prototype stage, developed under contract with the Post Office for handling mail; another installation with a different system for parcel post.

COMPONENTS FOR AUTOMATIC MACHINES

Control functions are the same whether for the product being made or the machine to make the product. These recent articles have special application to automatic manufacture.

"17 Typical Pre-assembled Fasteners," June 9 '58, p 78. A staff survey of new types applicable to automatic assembly.

"Memory Valves for Logic Circuits," May 26 '58, p 76. How the MEMORY function in electric control can be obtained in air systems for automatic sequencing.

"Basic Feeders for Parts," May 12 '58, p 96. Quick review of 7 different hopper feeding methods.

"Check Chart for Part Complexity," Mar 31 '58, p 124. Graphical guide to complexity as it affects automatic assembly; "complexity number" as a guide to shape selection.

"Maintenance Advice for Fluid Circuits," Mar 17 '58, p 71. Checklist of principles that will keep hydraulic equipment working properly.

"When Pistons Need Brakes," Feb 3 '58, p 56. How to take the bang out of end-of-stroke forces.

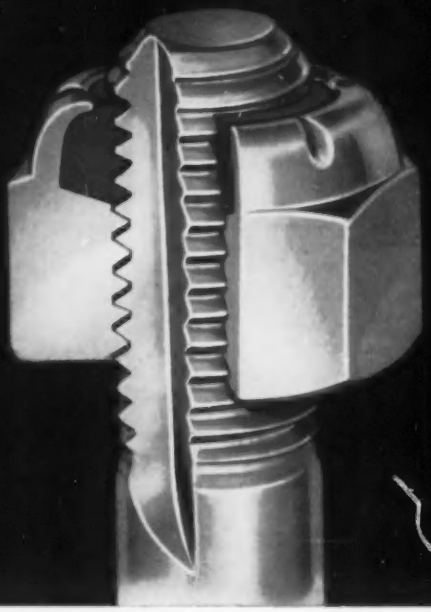
"Bearings That Don't Need Press Fits," Jan 6 '58, p 67. Penetrating liquid polymer replaces mechanical holding.

"Functional Gage for Flat Spring," Dec 9 '57, p 76. Rapid and precise test methods predetermine performance in use.

"Relays for Step-by-step Circuits," Nov 11 '57, p 101. How to use them in automatic controls to find, correct, time and count.

. . . And many more in earlier issues giving factual design data on components and systems for automatic operation.

The nylon collared Elastic Stop® nut never damages bolt threads!



The nylon locking insert * will not seize threads, gall or remove plating

The red nylon locking collar is an integral part of an Elastic Stop nut. Undersize in diameter in relation to standard bolt tolerances, this insert grips the entering bolt threads with strong, smooth nylon fingers that dampen impact loads and resist turning under the most severe conditions of vibration or shock. The perfect fit between bolt threads and the locking collar also serves to seal off internal bolt and nut threads and to protect them against corrosion. Furthermore the nylon insert is impervious to gasolines, oils, salt atmospheres, cleaning compounds and common acids. The remarkable wear resistance of nylon plus its elastic recovery makes Elastic Stop nuts reusable through more than a hundred on and off cycles.

Because an Elastic Stop nut is a one-piece unit it is less expensive to install than castellated nuts and cotter pins, or double nuts. Equally important, it is a *stop* nut that *locks at any position on the bolt* without requiring secondary "safety" devices; it is simple to adjust precisely—it is easily wrenched off or readjusted. Elastic Stop nuts have been used by American industry since 1930 to solve the toughest applications on railroad, automotive, earth moving and farm equipment, as well as on all types of electrical machinery.

Elastic Stop nuts are available in sizes ranging from a watchmaker's 0-80 through 3", and in many standard finishes and materials including carbon and stainless steels, brass, duronze and aluminum.

ELASTIC STOP NUT CORPORATION OF AMERICA

ESNA

also maker of the ROLLPIN®

*The Red Locking Collar is a Registered Trademark of ESNA

Elastic Stop Nut Corporation of America
Dept. N27-62, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

☐ ELASTIC STOP nut bulletin

☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____

Company _____

Street _____

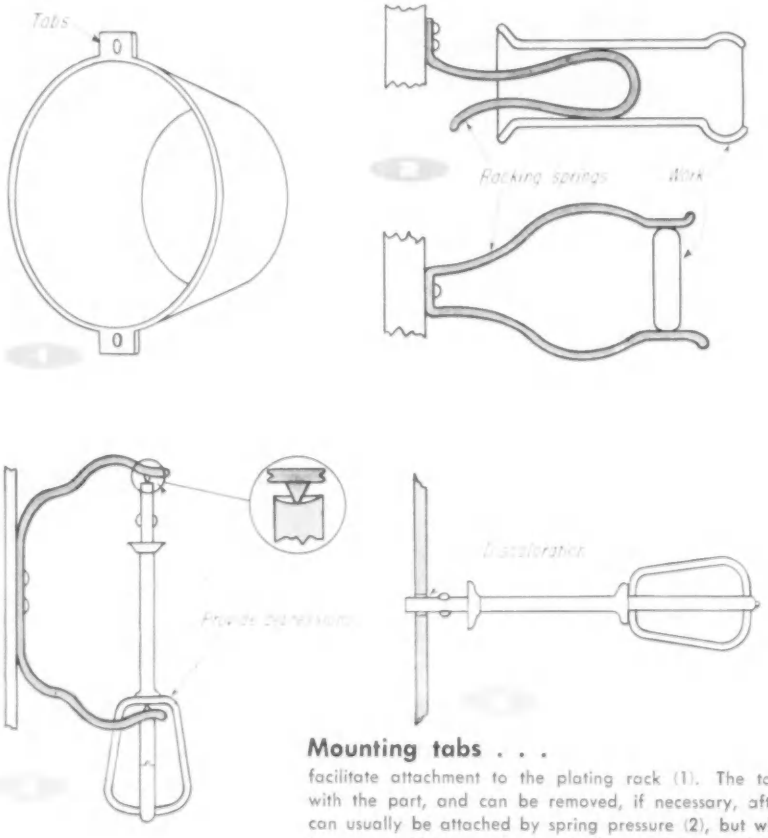
City _____ Zone ____ State _____

CIRCLE 152 READER SERVICE CARD

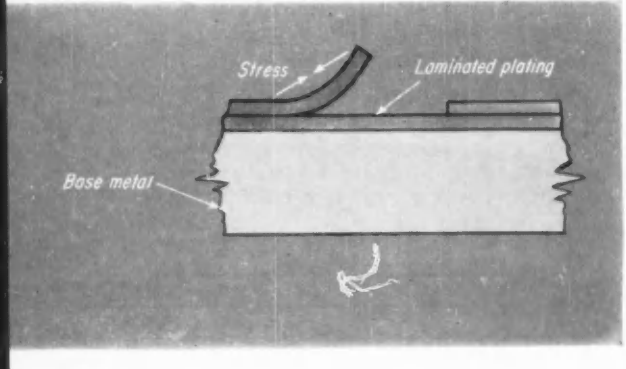
For BETTER

. . . better mounting, drainage, radii

Here are examples of things to remember when plating is planned—14 hints covering grooves, holes, deep draws will appear in a coming issue.



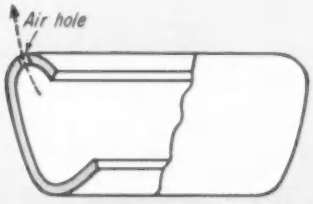
Mounting tabs . . .
facilitate attachment to the plating rack (1). The tabs are blanked with the part, and can be removed, if necessary, after plating. Part can usually be attached by spring pressure (2), but where it has been in contact with the workpiece (3) there will be no plating. Often there will be discoloration of adjacent plating. Depressions should be provided in the part (4) where the lack of plating will be least noticed.



Peeling results . . .
when point of attachment is not firm. Any wobble caused by solution agitation will result in laminated plating because of intermittent electrical contract. The laminations, under stress, will peel.

ELECTROPLATING . . .

PETER C. NOY, *Manufacturing Engineer, Canadian General Electric Co., Ltd., Barrie, Ont.*



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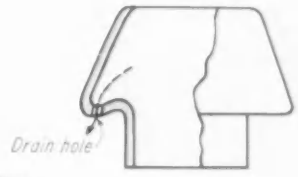
Air-relief hole . . .
should be provided wherever an air trap is likely to occur. Plating would not be deposited inside parts similar to the one illustrated unless a hole allowed release of trapped air during submersion.



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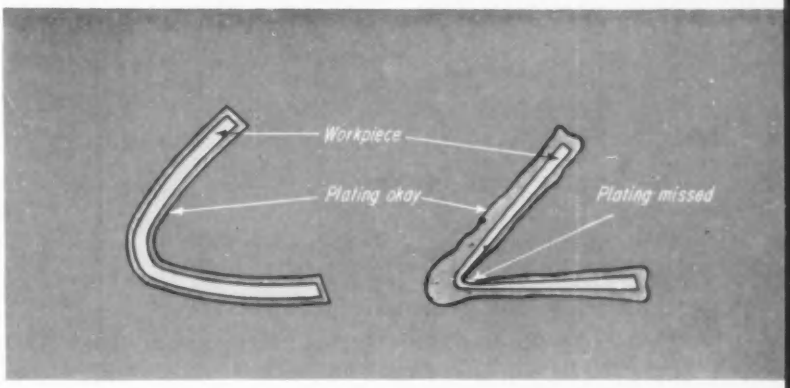
Drain hole . . .
releases solution which would otherwise be trapped inside a part, causing solution "drag-out." Plating solutions are expensive and, in a well-regulated bath, drag-out losses are often the highest cost item. Undrained solution washed away by subsequent water rinses is literally money down the drain!

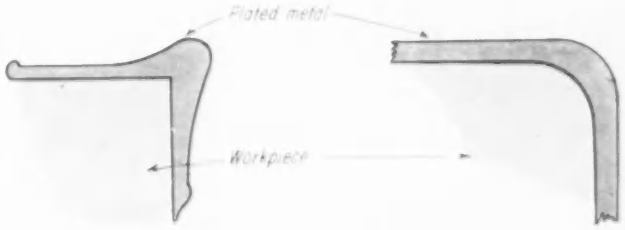
8

Inside-corner . . .
radii should be large as possible. In theory, plate can not be deposited where an inside corner is less than 90°. Plating thickness at such corners is vastly improved by large radii. If radii are less than ¼ in., auxiliary anodes may be necessary to achieve sufficient plate thickness.



9

Outside-corner radii . . .
should also be large. Nickel builds up on prominences because the current tends to be greater there. Often, the plater must provide metal fingers called "robbers" on his plating rack. Being cathodic, they help to distribute current density, for even plating.



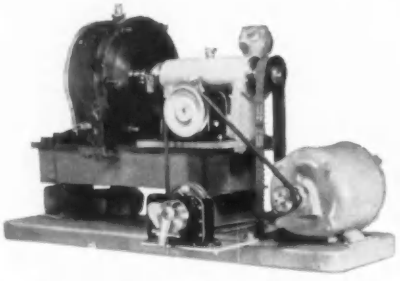
Automatic transmission seal problem—

New National Syntech® proves dependable answer in front pump seal position

Constant temperatures of 250°F, peaks of 300°, continual change in shaft speed, and total inaccessibility of the seal without costly teardown—these are a few of the sealing problems in the front pump of today's automatic transmissions for passenger cars.

To help meet this challenge, National engineers have produced a new oil seal. The new design, a steel encased, spring-loaded unit with Syntech synthetic sealing lip, is characterized by an unusually long flex section in the lip, a special, light-loading tension spring, and the time-tested, low torque Syntech lip itself.

Factory engineers report that the new National seals are proving extremely reliable in the application. Dealers also find the front pump seals are very reliable and do not require early replacement.



To design and thoroughly test the new seal, National engineers developed a new transmission simulator which exactly duplicates front pump operating conditions at all car speeds.

Get real help on seal engineering problems. Call the National Engineer.

NATIONAL SEAL Division, Federal-Mogul-Bower Bearings, Inc.

General Offices: Redwood City, California; Plants: Van Wert, Ohio, Downey and Redwood City, California

foreign digest:

EUROPEAN SOLDER DEVELOPMENTS

A roundup of metal-joining advances—from recent patents and other sources—covers new solders and techniques.

Under the title, "Summary of Progress Since 1945 in the Composition of Soft Solders," Hans Reininger, a German consulting engineer, has sifted literature on 66 soft solders. It is interesting to note that most of the literature surveyed was either US or British. Here, we present data from foreign-language sources that are less available to English-speaking readers. Four English-source summaries of interest, are also included. This PRODUCT ENGINEERING digest is from M. Reininger's article in *Der Maschinenmarkt*, No. 92, Nov. 15, 1957, published in Wurzburg.

A large number of the advances in soldering methods reflect the interest in finding better methods to solder aluminum. Developments also include solders for other metals, and techniques of general interest.

SOLDER FOR ALUMINUM

Preplating Method

The aluminum is first treated with a solution of orthophosphoric acid and nitric acid (50 to 80% water, 10 to 30% orthophosphoric acid, 5 to 20% nitric acid). This removes the oxide. The surface is then washed, dressed and tinned with molten tin by rubbing it on from a tin rod. Now the surface is easily soldered with commercial lead-tin soft solders. The soldered area is, however, not corrosion resistant and must be protected (Swiss Patent 2685 542, Aug. 1950).

Non-corroding

Especially suitable for parts exposed to sea water, this solder contains 30 to 45% tin, 35 to 50% cadmium and 5 to 20% silver. Eng. Pat. 571 208, Aug. 1945, by F. Strasser & A. Clavel.)

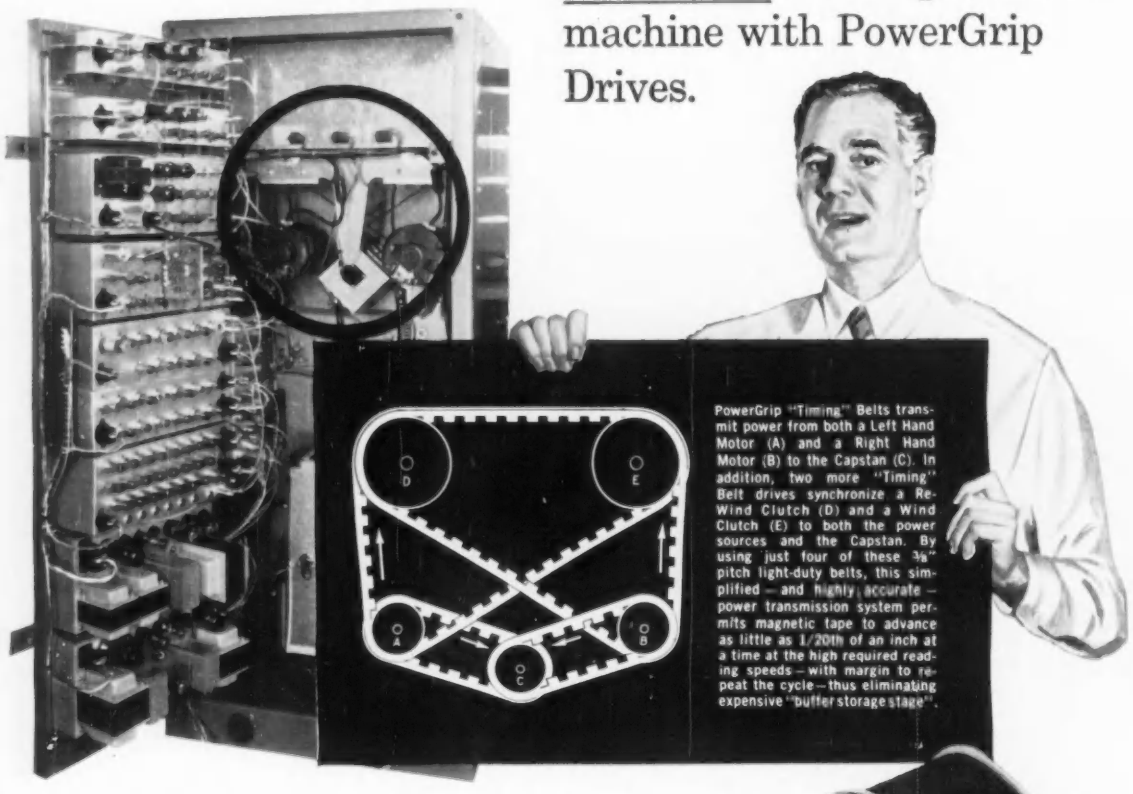
For Compressor and Refrigerator Parts

This solder does not become brittle at low temperatures: 94% zinc, 4% aluminum, 2% magnesium; melting point 350° C., easy flowing. Contamination with iron, manganese, tin, lead and

(Continued on page 99)

US RUBBER **PowerGrip "TIMING" BELTS**

"GRIP" POWERS tells how they improved the sale-ability of this precision machine with PowerGrip Drives.



PowerGrip "Timing" Belts transmit power from both a Left Hand Motor (A) and a Right Hand Motor (B) to the Capstan (C). In addition, two more "Timing" Belt drives synchronize a Re-Wind Clutch (D) and a Wind Clutch (E) to both the power sources and the Capstan. By using just four of these 3/8" pitch light-duty belts, this simplified – and highly accurate – power transmission system permits magnetic tape to advance as little as 1/20th of an inch at a time at the high required reading speeds – with margin to repeat the cycle – thus eliminating expensive "buffer storage stage".

The Shepard Servo Transport Digital Tape Reader, shown here, is used to match the speed of electronic information being fed from high-speed data processing machines to the speed of the apparatus which transcribes the electrical impulses into readable typewritten copy.

By incorporating PowerGrip "Timing"® Belt drives into this system, the following sales advantages were gained:

- *no maintenance problems*... no lubrication, no take up or other special alignment required; drives will last for the life of the machine.
- *vibration-free transmission*... belts run smoothly and quietly with constant angular velocity.
- *handles high shock loads*... slippage and belt friction eliminated; steel cables imbedded in the belt provide high tensile strength.
- *lower cost*... PowerGrip costs ½ as much as previous drive; saving is passed to the customer.

Says E.J. Quinby, Product Manager: "We use these belts because exhaustive research by us has proven them superior in speed—accuracy—reliability – durability – silence – freedom from periodic adjustment."

Check the *sales advantages* PowerGrip "Timing" Belts can add to your designs.

• • •

When you think of rubber, think of your "U.S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

US RUBBER **Mechanical Goods Division**

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EUROPEAN SOLDER DEVELOPMENTS

antimony not harmful if impurities are below 1% total. (French Pat. 964 788, Aug. 1950, Soc. d'Electro-Chimie.)

For Sheets

This solder is 73% tin, 2.3% cadmium, 4% germanium; melting point is well below 350° C. Sheet strength is not impaired. (Swiss Pat. 268 226, Aug. 1950, Ateliers de Carouge S.A.)

For Thin Foil

This corrosion-proof solder is 3.8% aluminum, 0.8% copper, 0.02% manganese, remainder zinc. M.P.: about 340° C. Additions that harden solder are harmful if joint is to be exposed to low temperatures. (French Pat. 957 701, Feb. 1950. Applications Industrielles, Soc. An., Switzerland.)

Supersonic Soldering

Aluminum is tinned and soldered under supersonic treatment with either pure tin or tin containing up to 10% lead. (French Pat. 1 041 983, Oct. 1953, Siemens Schuckert werke A.G.)

Aluminum to Aluminum

Solder is 80 to 90% tin, 10 to 14% zinc, 0.3 to 1.2% aluminum, and 0.3 to 1.2% silver. It is made by first melting only 15% of the tin, then adding the other ingredients. Only after the whole mixture has melted is the remainder of the tin added. This solder is said to need no flux; the soldered joint is shockproof and can be hammered. (Austrian Pat. 173 928, Feb. 1952, by K. Seidl and E. Swetlik)

OTHER SOLDERS

Universal Soft Solder

For all metals (although not the optimum for all conditions): 50 to 60% tin, 30 to 40% zinc, 2 to 5% antimony, 1 to 4% lead, 3 to 8% copper, 1 to 4% cadmium. The flux used with this solder is 40 to 60% zinc chloride, 30 to 40% ammonium chloride, 6 to 10% copper chloride, 4 to 8% lithium chloride, and 1 to 3% powdered copper. (French Pat. 964 917, Aug. 1950, Soc. An. Fontalum.)

Lead Solder

This solder, with a relatively high melting point, is 78% lead, 10.3% antimony, 7.7% silver, 1.5% copper, 2.5% cadmium. (French Pat. 1 005 470, April 1954, Comp. Francaise Thompson-Houston.)

Attaching Metal Foil to Glass

A method that can be also used for quartz, ceramics or silicon products is described by R. B. Belser in *Rev. Sci. Instruments*, Feb. 25, 1954. The solder is indium or its alloys, without any flux. Bonding strength is 0.35 kg/mm² (= 480 lb/sq in.)

Soft Solder

A formulation by British Insulated Callender's Cables, Ltd., London (English Pat. 733 482, July 1955) contains 52% lead, 40% tin, 8% zinc, 0.1% sodium. Neither antimony nor any other alkali metals must be present.

SOLDERING TECHNIQUES

Ferrous Parts

Parts that have been coated galvanically with cadmium or zinc are treated with chromium salts and soldered with a solder of at least 20% tin content. (French Pat. 1 056 882, March, 1954, N. V. Philips Gloeilampenfabricken, Eindhoven, Holland.)

Soldering Bit

Made of 58 to 65% copper, 35 to 42% zinc, 0.5% tin, and 0.5% silicon, this alloy is malleable, does not scale even when white-hot for long periods, and no filing or tinning is necessary. (English Pat. 676 476, July 1952, by J. L. D. Oakley.)

Soldering Rod

For aluminum, beryllium, tantalum and their alloy. The rods are 70% tin, 30% zinc; or 60% bismuth, 40% cadmium. Rods contain a core of nonmetallic abrasives, e.g. carborundum, tungsten carbide or glass. These remove oxide layer when the rod is rubbed on the workpiece during soldering, and roughen the surface. The abrasive can also be mixed with the solder without forming a core. Flux is not necessary. (English Pat. 720 424, Dec. 1954, by General Electric Co.)

To Remove Soldering Residues

Workpieces are submerged for 10 to 60 min. at 80 to 90° C in a bath of the following composition: 500 g sodium cyanide and 10 g sodium ferrocyanide per 1 liter (approximately one quart) of water. (French Pat 1 007 850, May 1952, by Ch. P. Suppo.)

To Avoid Cracking of Tin Plate

It has been found that a uniform thickness of the tin coat is of utmost importance. (Hoare, W. E., and Gustin, J. P., in *Revue Metallurgie*, May 10, 1953.)

Russian Journal Tecn. Physiks

Kischkin, Nikolenko and Ratner (No. 24, Aug. 1954) found that strength of solder joints on steels depends on composition of both the steel and the solder, and also duration of the strain. Tin-lead solders appeared weaker than lead-silver solders. Recommendations: first plate the workpiece with copper or nickel; use a lead-silver solder; avoid stresses on the joints; solder as fast as possible at the lowest possible temperature.

For Disconnecting Joints

Method described by R.C.A. (US Pat. 2704707), for disconnecting solder joints, exposes them to mercury vapors, whereby the solder and metal amalgamate. This method is, of course, applicable only to metals capable of amalgamation, as silver, copper, gold, lead, tin, cadmium and aluminum.

The Set Screw locks key in place, prevents "key drift," a necessary safety feature.
The Clamp Screw locks hub to shaft for permanent alignment. Hub is locked in one piece so there is no distortion as set screw is drawn down.

In Worthington QD Sheaves these extra

2 SCREWS MAKE THE DIFFERENCE

Exclusive features of Worthington QD Sheaves...

EASY ON! Two-piece design lets you install the sheave *one part at a time*. No heavy rim and hub combination to inch into place; the tapered hub slides easily on the shaft, is locked by the clamp screw for permanent alignment. The set screw locks key. Then the sheave rim slides easily into position on the taper-seat of hub because the large end of taper in sheave starts engagement with small end of taper on hub. Heavy hex-head bolts complete the assembly.

EASY OFF! Remove the big pull-up bolts and use two as jack bolts for easy rim removal. To change speed it's simple to mount a larger or smaller sheave on the hub which, because of clamp screw, remains aligned on shaft. You can install or remove one part at a time.

ALWAYS TIGHT! Severe shock or reversing loads cannot loosen the sheave. Tightening the pull-up bolts locks the hub to the shaft as tight as if the sheave were integrally cast with shaft. The set screw anchors the key in position.

COMPLETE STOCK! You can get Worthington QD sheave stock service anywhere in the U. S. More than 350 distributors carry Worthington sheaves and Worthington-Goodyear Green Seal V-belts. For 100 page Multi-V-Drive Manual on how to select the right sheave and V-belt write to Section 79-10, Worthington Corporation, Harrison, N. J.

WORTHINGTON

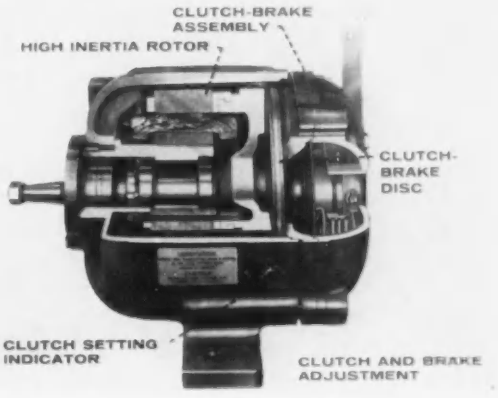
CIRCLE 155 READER SERVICE CARD

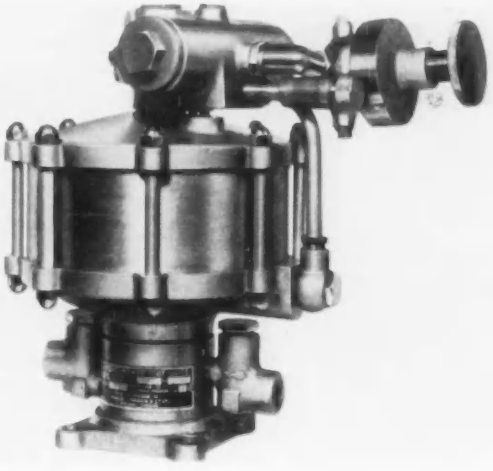
NEW COMPONENTS and MATERIALS

Clutch-brake motors . . .

employ a constantly rotating high inertia rotor to provide stored energy for fast starts under suddenly applied loads in metal-working and automatic production machinery. Clutch-brake assembly, integral with the motor, is actuated by a lever operated by a double-acting solenoid, or air or hydraulic cylinder. Upon actuation, lever engages clutch with continuously revolving rotor. Instant power, with minimum fluctuations of speed and motor current, is said to result; and impulse-applied loads, up to 10 times rated value of the motor, can be accommodated. Opposite actuation of lever disengages clutch and causes brake to stop output shaft. Clutch-brake assembly can be removed from housing without disconnecting motor from mounting. Standard motors range from ½ to 5 hp and many are available from stock. Prices start at $100. **Ferguson Machine Corp. of Indiana, 7818 Maplewood Industrial Court, St. Louis 17.**

Circle 1, inside back cover





Converts air to hydraulic pressure at ratios to 225:1 . . .

with nine models covering a hydraulic pressure range of 62 to 22,500 psi. This new intensifier operates on a compressed-air supply of not more than 100 psi. Units weigh from 50 to 80 lb. Air pressure applied to a large air piston imparts an intensified thrust to a hydraulic ram of smaller area. Air reducing and control valve produces intermediate pressures within range of each model. Pumps maintain a static pressure indefinitely without consuming air, and will adjust sufficiently to compensate for system leaks or movement of loaded machine members. Air consumption is limited by, and in proportion to, amount of hydraulic fluid delivered by pump. Suitable for water, kerosene and most hydraulic fluids. Models are 12 in. high; over-all dia varies from 7½ to 12 in. Made in England. Price range, $420 to $510; delivery, 2 wk. **Davies Bros., Gladstone, N. J.**

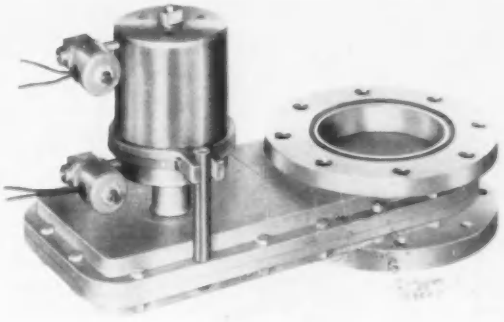
Circle 2, inside back cover

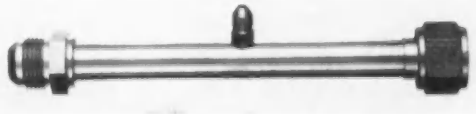
Linear is converted to rotary . . .

motion with high torque by linear movement of a guided plunger along a spirally fluted shaft in a pneumatically operated cylinder. Standard models currently available accomplish a 180° turn, but other constructions capable of up to several complete turns are possible.

A 3-in.-dia cylinder is 5½ in. long ($95) and a 5-in.-dia is 6½ in long ($125). Cylinder operates at air pressures available in most plants, and, if necessary, down to 50 psi. Manual or automatic closure upon power failure is possible. Either solenoid or air-operated valves may be used. Delivery from stock. **Vacuum Research Co., 420 Market St., San Francisco 11.**

Circle 3, inside back cover



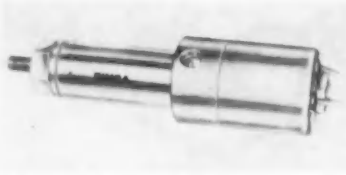


Precision flow-measurement . . .

system uses stainless steel tube with close-tolerance surface finish, dimensions and concentricity to check pressure and/or temperature levels. Tube sections are available ¼ to 2-in. OD, in lengths conforming to ASME and aviation standards; pressure ratings up to 5000 psi. **Kahn & Co., Inc., 547 Windsor St., Hartford 1, Conn.**

Circle 4, inside back cover

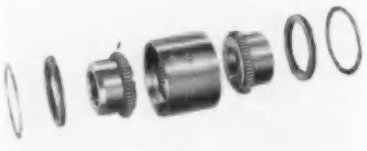
. . . CONTINUED ON PAGE 102



Stainless air cylinder . . .

has built-in solenoid valve. Units have 1⅛-in. bore (1, 2, or 3-in. stroke) and consist of a single-acting, spring-return, throw-away-type stainless steel air cylinder with 3-way, 115-v solenoid control valve built on end of cylinder. Cylinder body is mirror finished and units contain vinyl U-cups mounted in aluminum alloy piston. Valve is normally closed, and designed for continuous operation. Valves can be serviced and valve parts can be replaced without removing cylinder from line. Operating pressure is 150 psi max. Models are priced from $20.95 to $22.95. **Bimba Hardware & Mfg. Co., 103 Main St., Monee, Ill.**

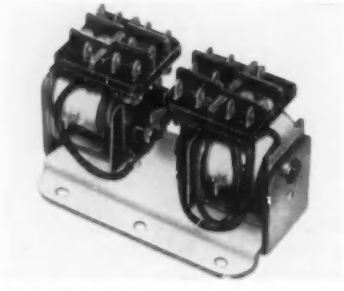
Circle 5, inside back cover



One-piece flexible coupling . . .

assembles and disassembles in seconds. Identical internal hubs, lube retaining rings, spring-steel snap rings and one continuous external sleeve are major components. Positive hub seals and ability to accommodate shaft angular misalignment up to 3° are said to make possible maintenance-free operation for 3 to 5 yr. Available for immediate delivery. **Zurn Industries, Inc., Erie, Penna.**

Circle 6, inside back cover



Latch relay . . .

is said to have a life of one million operations minimum. Rated 5 and 10 amp at 115 v ac noninductive or 26.5 v dc. Contacts are silver for 5-amp units and silver cadmium oxide for 10-amp units, with arrangements up to 6PDT. Operates on 6, 12, 24 and 110 v dc or 6, 12, 24, 115 and 230 v ac. Power consumption is 2.7 w min and 4 w max. Dimensions are 2⅜ x 1¾ x 2 in. high. **Line Electric Co., 271 S. Sixth St., Newark 3, N. J.**

Circle 7, inside back cover

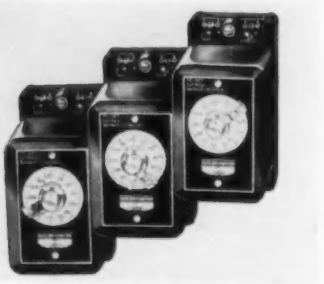
Photoelectric tachometer . . .

measures shaft rotational speeds or accumulated turns with up to 1° resolution on electronic counters. Generates constant-amplitude, equal-length output pulses as its shaft is turned and is available with output pulses per revolution of 60, 100, 120, 180, 200 or 360. It is all transistor-equipped and uses etched circuitry. Unit can be turned in either direction at speeds from 0 to 10,000 rpm. Dc response permits counting and totalizing of increments of shaft rotation at varying shaft speeds down to zero. Also measures transient rotational phenomena on an oscilloscope. The 3¾ x 3¾-in. cylindrical body mounts in any position. Operates in vibration environments and at temperatures of —14 F to 131 F. Operating power is 6.3 v ac at 150 milliamp. **Dynac, Inc., 395 Page Mill Rd., Palo Alto, Calif.**

Circle 8, inside back cover

Motor-driven timer . . .

with 1, 3 or 5-min timing units operates on 110 v ac, 60 cps. For 220, 440 or 550-v, 60-cps service, a control transformer with terminal block is added. The 1-min unit is adjustable in 1-sec increments, 0 to 60 sec; 3-min unit is adjustable in 3-sec increments, 0 to 180 sec; 5-min unit is adjustable in 5-sec increments, 0 to 300 sec. To set, bronze pointer is depressed and rotated to desired position on indicating dial. A terminal board and mounting



base combination provide interchange of dimensionally identical timing units. **Cutler-Hammer, Inc., 296 N. 12th St., Milwaukee 1.**

Circle 9, inside back cover

Quick-release pins . . .

of single-acting, double-acting (with or without detent) design are produced from non-heat-treated steel screw stock. Pins are also available in chrome moly steel,

heat treated to 160,000 to 180,000 psi. Standard finish is cadmium plated. For ultimate high-strength uses, pins are made of stainless steel, heat treated to 180,000 to 210,000 psi. Six handle configurations are offered. **D. W. Price Corp., 11161 W. Pico Blvd., Los Angeles 64.**

Circle 10, inside back cover

Hydraulic power check . . .

controls air cylinder piston rods and machine components, preventing chatter and aiding uniform feed. Consists of an oil-filled checking cylinder, adjustable metering valve and reservoir cylinder. Unit is installed by attaching cylinder to fixed portion of machine and piston rod to member to be controlled. As the rod is pulled out, the piston in the checking cylinder forces oil through a metering valve and back into opposite end of the checking cylinder. Control of oil flow, affecting speed of travel of the piston rod, also controls machine element to which it is attached. Controlled travel on forward and/or reverse stroke is possible. Model shown is capable of handling loads up to 3000 lb and available in 13 sizes with strokes from 2 to 20 in. Over-all collapsed lengths range from 17⅛ to 47 in. Cylin-

. . . CONTINUED ON PAGE 104

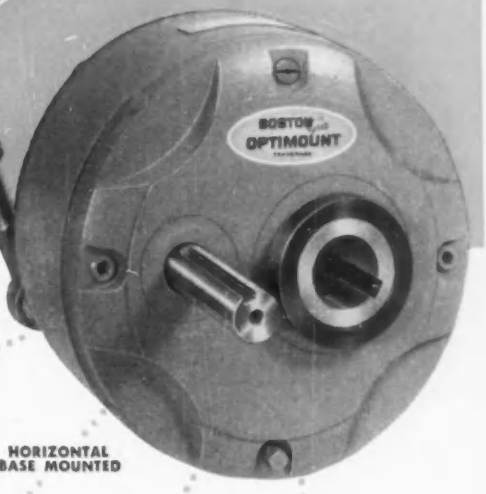
OPTIONAL MOUNTING
OPTIMUM PERFORMANCE

BOSTON Gear® OPTIMOUNT

TRADEMARK

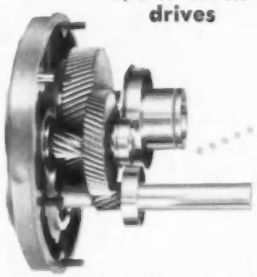
A *New* achievement in **STANDARDIZATION**
by industry's most experienced specialists in speed reducer design

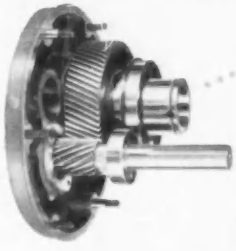
HELICAL GEARED
REDUCTORS • RATIOMOTORS
AND FLANGED REDUCTORS
SHAFT MOUNTED and BASE MOUNTED



From Stock

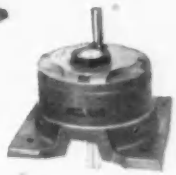
SINGLE or DOUBLE REDUCTION
1/6 to 15 HP drives





HORIZONTAL BASE MOUNTED

VERTICAL BASE MOUNTED



SHAFT MOUNTED

DELIVER MAXIMUM POWER with highest efficiency. Precision helical gearing made by BOSTON Gear specialists, — in units tested and proved to meet the highest quality standards.

ALL OPTIMOUNT Ratiomotors are available also without motors as FLANGED REDUCTORS. You buy and attach your own choice of motor

OPTIMOUNT offers you unlimited adaptability to modern drive demands, in helical geared speed reducers made to BOSTON Gear quality standards.

Call your Distributor for complete information. Let him demonstrate the design features that assure top-rated efficiency and lasting economy. Boston Gear Works, 71 Hayward St., Quincy 71, Mass.

66 MODELS FROM STOCK

680 OPTIONAL MOUNTING ARRANGEMENTS

For nearest Distributor LOOK UNDER "GEARS" in the 'Yellow Pages'

CALL YOUR BOSTON Gear DISTRIBUTOR

— STANDARDIZATION PAYS —

NEW Catalog OP-1 lists complete data on OPTIMOUNT, — selection charts, engineering data. Get your copy from your local Distributor.

CIRCLE 156 READER SERVICE CARD

Here's the **NEW** variable-speed, explosion-proof Model 16AM

GAST rotary vane AIR MOTOR

Newest and largest Air Motor in the Gast line, this Model 16AM may solve an original equipment (or plant use) problem for you! It's compact — only 14⅜" x 8" x 7⅝" high. It's light in weight — only 65 pounds. It delivers up to 7 h.p. with good torque characteristics.

Listing at $200, it offers unique advantages for driving equipment located near a compressed air source:

1. Speed infinitely variable from 300 to 2,000 r.p.m. with any simple air valve control. Air motors always run cool.
2. Explosion-proof design, safe in explosive atmospheres.
3. Can't burn out from overloads — stalling doesn't harm it.
4. Heavy-duty construction with ball bearings, dual seals.
5. Six vanes in rotor automatically take up their own wear for constant high efficiency and long life.

Designed to operate on air pressures from 30 to 90 p.s.i., Model 16AM is suitable for driving direct, through gear box or pulley. Foot (base) is standard. End plate also has four tapped holes for flange mounting to gear box or other driven unit.

Perhaps you can use air power on a hoist, fan, pump, mixer or other product. Write today for new Bulletin 16AM.

GAST MANUFACTURING CORP., P.O. Box 117-V, Benton Harbor, Michigan

SEE CATALOG IN SWEET'S PRODUCT DESIGN FILE & A.S.M.E. CATALOG

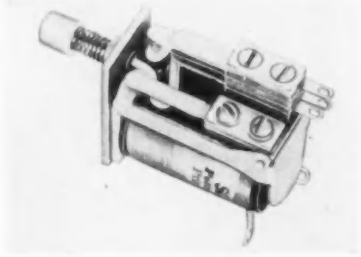
GAST ROTARY

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

der bore is 1.385 in. on all models; piston rod is ½ in. dia on models with stroke up to 6 in. and ⅝ in. dia on larger models. Meets or exceeds all AN or JIC specifications. **Appco Corp., P.O. Box 6, Olmsted Falls, Cleveland.**

Circle 11, inside back cover



Telephone type relay . . .

features a push-to-release reset level. Operates on 2.4 w, 25 millisec pulses and has available contact arrangements up to 4PDT. Can be furnished to operate on dc voltage or current values up to 110 v or 11 amp. When relay operates, a latch lever locks armature in position so that contacts remain transferred when power is removed from coil. Contacts, rated at 5 amp, 115 v, 60 cps resistive, return to their original position when reset lever is pushed to release latch lever. Relay measures ⅞ x 1⅝ x 1⅝ in. and weighs about 2 oz. Designed primarily as a voltage-operated latch-in relay for control systems where manual resetting is desirable. However, it can be used in overload applications that can tolerate pull-in point deviations of 10%. **Potter & Brumfield, Inc., Princeton, Ind.**

Circle 12, inside back cover

Motors with oil reservoirs . . .

incorporate feed devices that admit oil to sleeve bearings in controlled quantity after original bearing lubricant is expended. Oil is retained in reservoir by a mechanical stopper. A wear-stem of controlled-density carbon rides motor shaft and begins to wear after a predetermined length of time. Wearing of the stem triggers release of the stopper, allowing lubricant to enter bearing wick cavity. Level is controlled by a built-in oil-level control tube.

(Continued on page 107)

SEALMASTER'S® EXCLUSIVE COMBINATION OF FEATURES ARE SETTING THE PACE!

When you design, you design your products for maximum performance—and **Sealmaster** helps you attain it. **Sealmaster** Ball Bearing Units are engineered and manufactured with the same painstaking quality control you would insist on maintaining within your own plant. **Sealmaster's** exclusive combination of features assure you of maximum performance for each bearing. You'll want full information on how important these features are to you and your own product's performance.

LOCKING PIN & PERIMETER DIMPLE—prevents rotation of outer race and assures positive lubrication.

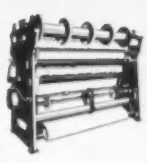
LABYRINTH-SEAL—keeps dust and dirt out and lubricant sealed in for long bearing life.

ZONE HARDENING—assures positive race to shaft holding power.

LANDRIDDEN BALL RETAINER—eliminates ball wear, traps grease and prevents churning.

...For Outstanding Bearing Performance

MACHINE TOOLS
SEALMASTER quality pays off where the trend is to continuous, fast, automatic equipment.



TEXTILE INDUSTRY
Clean, fast production is assured with SEALMASTER Bearings.

FARM MACHINERY
SEALMASTER Ball Bearing Units keep dust and dirt out, lubricant in—a feature Farm Machinery demands.

CONVEYORS
SEALMASTER Ball Bearing Units are featured by manufacturers of many types of conveyors.

AIR CONDITIONING
Quiet, trouble-free performance is assured with SEALMASTER. Find out about new rubber mounted units.

CONSTRUCTION MACHINERY
SEALMASTER Ball Bearing Units provide the features for gruelling performance in construction and materials handling equipment.

SEALMASTER® BALL BEARING UNITS

Write for Bulletin 454

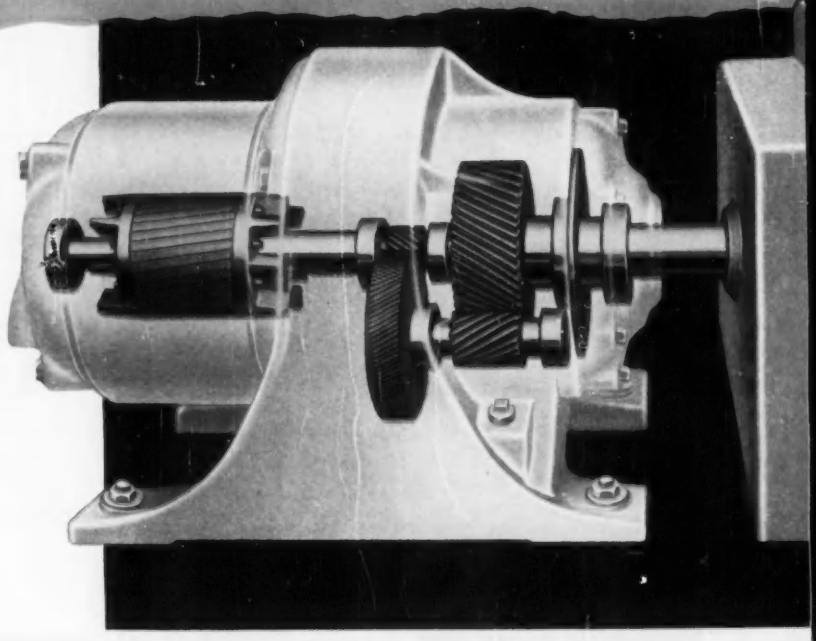
SEALMASTER BEARINGS A DIVISION OF STEPHENS-ADAMSON MFG. CO. 9 RIDGEWAY AVENUE, AURORA, ILL.

why use complex contraptions?

simplify...

with this self-contained geared power package...

U.S. Syncrogear motor!

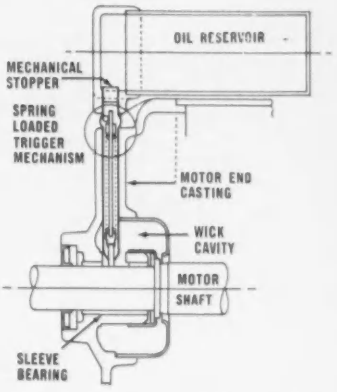


Don't trust your production to cumbersome contraptions that slip... misalign... and create operator safety hazards. Instead of buying a "unit" that requires belts, pulleys, separate motor, and turnbuckle or rails to be added at extra expense... instead of spending costly production time on recurring adjustments—take the easy, simple, economical way to geared power with U.S. Syncrogear Motors. Syncrogear Motors can't slip! Can't misalign! Can't endanger operator! They give you *positive* power delivery in one compact, self-contained package—steady slow shaft-speeds, permanent precise alignment, maximum efficiency and long life. Best of all, U.S. MOTOR dependability! Available in RATINGS 1/3 TO 30 H.P.

U.S. ELECTRICAL MOTORS INC.

BOX 2058, LOS ANGELES 54, CALIFORNIA
OR MILFORD, CONNECTICUT

SEND FOR FREE 16-PAGE BROCHURE...
illustrated in full color... on U.S. Syncrogear motors.



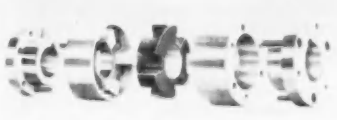
Standard motors are available in ¼ to 1½-hp rating in 56-frame construction. Particularly applicable to air conditioners, attic fans, automatic washers, clothes dryers, industrial machinery and refrigerators, all of which require lubrication, but typically are either neglected or over-lubricated. **Franklin Electric Co., Inc., Bluffton, Ind.**

Circle 13, inside back cover

Fail-safe relay . . .

senses phase sequence of a 3-phase power supply and closes a contact only when applied phase sequence is A-B-C. Relay contact is normally open. Operates on 115 to 200 v ac, 400 cps in ambient temperatures of −65 to 160 F. Withstands vibration of 10 g to 500 cps and shock of 15 g for 11 millisec. The 10-oz relay meets military specifications for use under severe environmental conditions. Hermetically sealed unit is for use on ground or airborne equipment. A plug-in connector and mounting plate simplify installation. **Master Specialties Co., 956 E. 108 St., Los Angeles 59.**

Circle 14, inside back cover



Flexible drive coupling . . .

is made entirely of magnesium alloy, which provides steel strength with an 80% reduction in weight. Couplings are installed by being slipped over shafts and are made vise-tight by separate split hubs that fit into coupling halves. Socket-head screws draw the two together and compress split hub around shaft. All hubs, regardless of bore sizes, are interchangeable in couplings of each model size. Drive is transmitted through a lugged neoprene drive insert, providing an in-

(Continued on page 111)

Design flexibility
full strength value developed every time wide grip range

Improved appearance for greater salability
can't mar surfaces
create modern contours and shapes

Increased production
rapid one-man installation from one side
no special training required for workers

Reduced customer maintenance
rivets can't vibrate loose, which eliminates the inconvenience and expense of repairs

For full information, write to Townsend Company, P.O. Box 237-D, New Brighton, Pa., asking for Bulletin TL-124.

*Patents issued and pending

The Fastening Authority

Townsend

COMPANY • ESTABLISHED 1816

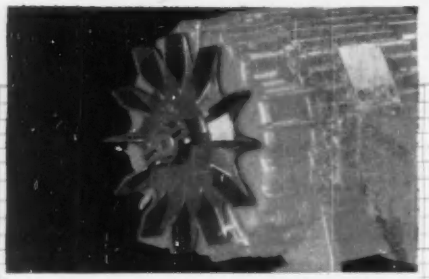
NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

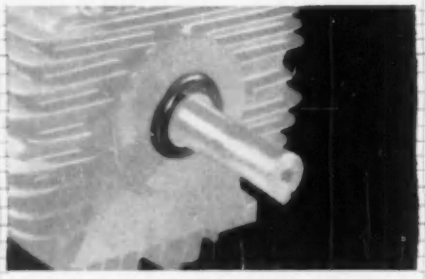
Cherry Rivet Division • Santa Ana, California

In Canada: *Parmenter & Bulloch Manufacturing Company, Limited, Gananoque, Ontario*

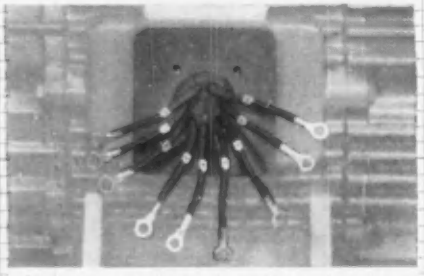
ELLIOTT C-W SEALEDPOWER



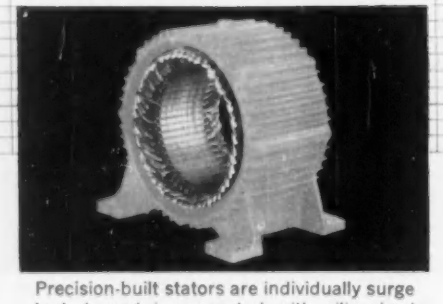
Sturdy external fan has a split hub both keyed to the shaft. No chance of slippage or loosening.



A slinger on the motor shaft effectively guards against the entrance of moisture and foreign material. Slinger is recessed into the bearing bracket to provide a long, labyrinth-type seal.



All leads pass through a grommet as they are brought out of the motor frame. When conduit box is mounted in position, the grommet is tightly compressed, providing a snug seal at this vulnerable area.



Precision-built stators are individually surge tested, and impregnated with siliconized varnish, for improved heat stability and heat resistance.

CIRCLE 161 READER SERVICE CARD

. . . designed for the dirty jobs

Elliott C-W Sealedpower motors can safely be installed outdoors, or in dusty, moist and corrosive atmospheres. Internal parts are thoroughly protected from the environment. Many users have standardized on this type of motor for all applications because they find that the total cost—first cost plus maintenance—is less for totally-enclosed motors than for conventional enclosures!

This popular, dependable group of motors is part of the Elliott C-W line, which includes also standard Dripproof-protected and Explosion-proof designs.

The original C-W fin-cooled, self-cleaning design which provides more cooling area—no internal passages to clog.

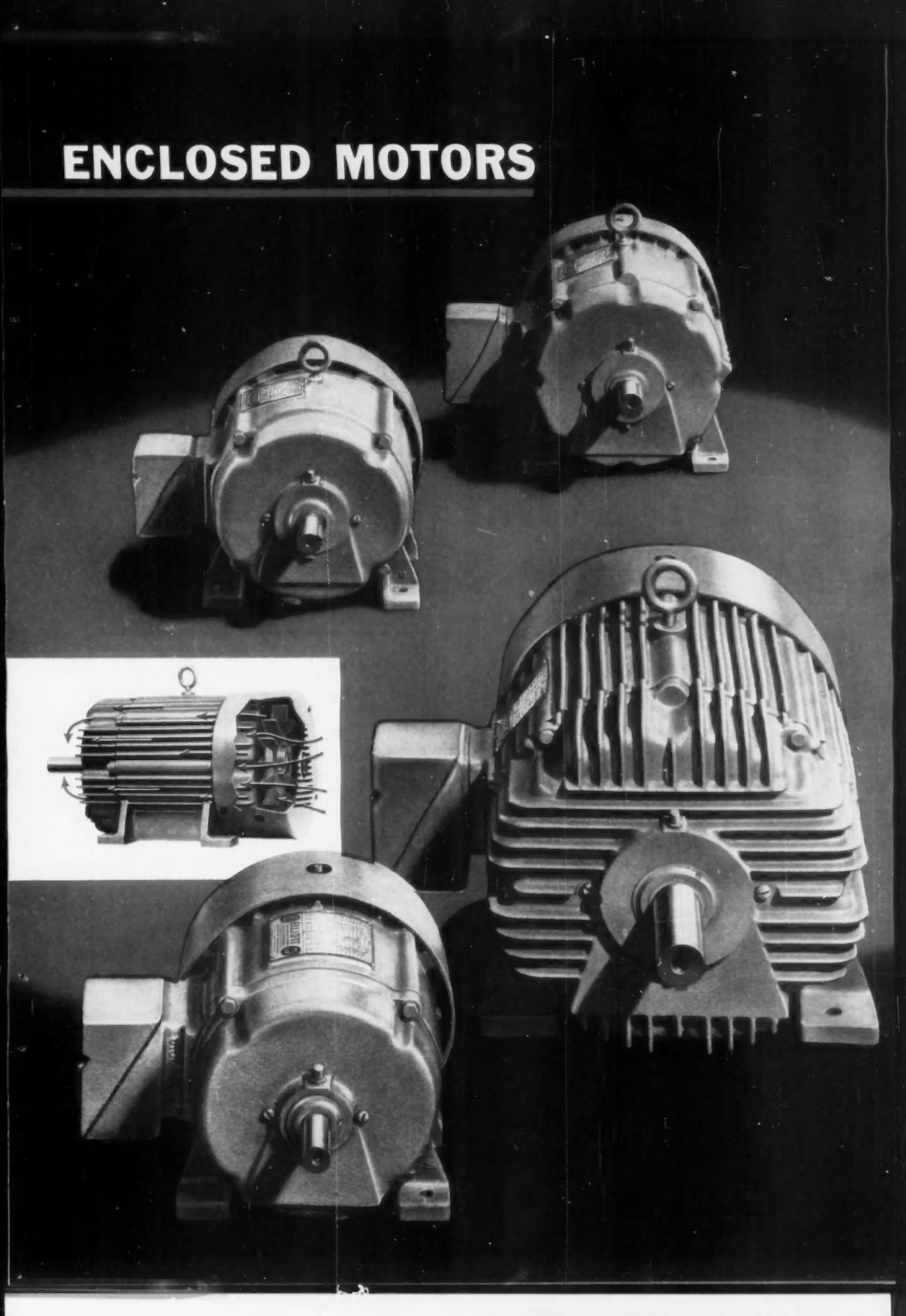
ELLIOTT Company

CROCKER-WHEELER PLANT, Jeannette, Pennsylvania

Write for Bulletin PB 6000-6, which describes in detail the features which make Elliott C-W motors outstanding.

WB-2

ENCLOSED MOTORS



Weldynamics

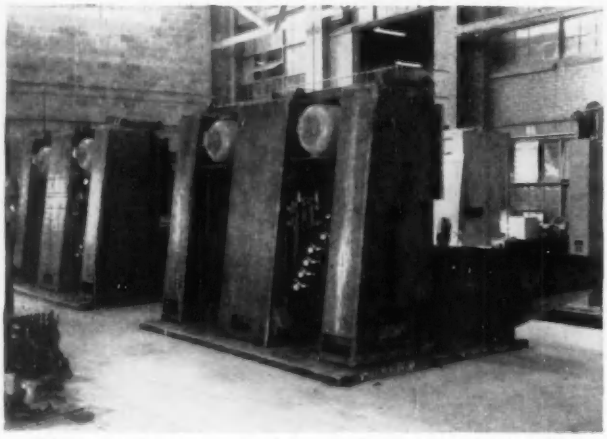
ARC WELDING AT WORK CUTTING COSTS

33-ton grinder engineered and built in 4 months . . . savings $4800 with Weldynamics

Weldynamics made possible savings of $4800 and permitted fabrication of this machine in just four months.

The savings are possible because steel is 3 times stronger and 2½ times as rigid as iron. Thus less material is needed. Pattern expense is eliminated.

Time is saved because parts can be preformed while final assembly drawings are still in process.



Belt grinder for automotive industry designed and fabricated by The Curtis Machine Corporation, Jamestown, New York.

let WELDYNAMICS cut your costs

Lincoln men, trained in Weldynamics, will help you design your product for lower costs. They will advise and recommend proper procedures, equipment and electrodes to save time and expense in fabrication.

New, 11th edition, "Procedure Handbook of Arc Welding Design and Practice" has 1300 pages, 1100 illustrations, 240 pages on machine design. $3.00 in U.S.A., $3.50 elsewhere.

Send for Machine "Design Ideas". Free to Designers and Production Supervisors.

The World's Largest Manufacturer of Arc Welding Equipment

LINCOLN®

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THE LINCOLN ELECTRIC COMPANY, DEPT. 1328, CLEVELAND 17, OHIO

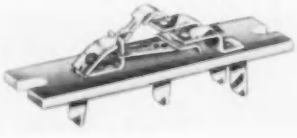
sulated, nonlubricated connection, absorbing misalignment and shock. Made in eight sizes to accept shafts from ¾ to 6 in. **Detroit Power Coupling Co., 992 W. Seven Mile Rd., Detroit 3.**

Circle 15, inside back cover

Air filter . . .

removes harmful moisture, rust, pipe scale and other contaminants from air lines. Large petcock at bottom permits removal of harmful materials. Construction simplifies disassembly for cleaning. **Gits Bros. Mfg. Co., Pneumatics Div., 1866 S. Kilbourn Ave., Chicago 23.**

Circle 16, inside back cover



Split-contact switch . . .

has one common ground, one normally closed and two normally open terminals. It is reported to offer advantages of multiple circuit switching at low cost. Available with variations in terminals, electrical rating, actuator designs, contact arrangements and mounting panels. Illustrated is a vending machine installation. Contacts and contact bar are silver. Switch, 2¼ x ¾ x 1 in. high, is rated 5 amp, 125 v ac normally open; 10 amp, 125 v ac, normally closed. **Cherry Electrical Products Corp., 1650 Deerfield Rd., Highland Park, Ill.**

Circle 17, inside back cover

Miniature circuit breaker . . .

is rated 65 v dc, 250 v ac, 0.05 to 6 amp, and may be used for electronic control mechanisms and other applications requiring quick-release protection. Operates on thermal-magnetic principle and protects against overload and shortcircuit conditions. Circuit cannot be restored while short circuit exists. Breakers feature

(Continued on page 114)

CHEMISEAL® NYLON

performer

Design to use Chemiseal Nylon (du Pont ZYTEL) for those mechanical and electromechanical parts that must be strong, durable, wear resistant. It has the highest compressive strength, is the most rigid, has the best resistance to heat, abrasion, chemicals, solvents, oils and greases. And it is the lowest priced of the standard nylon compositions.

Coupled with U.S.G.'s Injection Molding "know-how"—Chemiseal Nylon assures you the lowest cost, precision parts, in volume production. And we specialize in handling designs difficult to mold.

U.S.G. Nylon service goes all the way—offering not only injection molding of parts but also a complete stock of bubble-free Nylon rod, standard and pressure tubing, tape and extruded shapes. In addition, extensive, specialized facilities for high speed automatic machining of parts from stock to your specifications.

For prompt service, contact one of The Garlock Packing Company's 30 sales offices and warehouses throughout the U.S. and Canada, or write

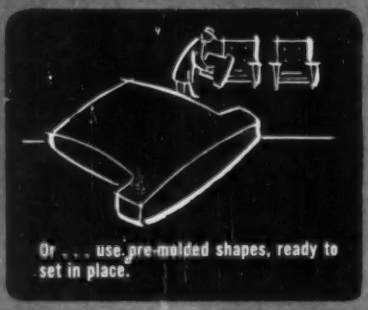
United States Gasket Company
Camden 1, New Jersey

United States Gasket

Plastics Division of

GARLOCK

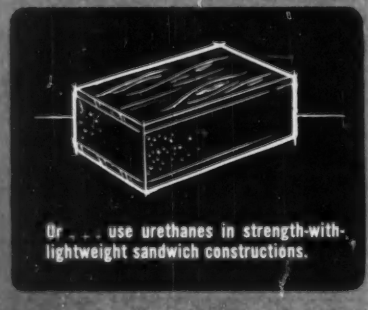
Begin with slab stock. Flexible foams can be cut, sliced, die-cut, sewn, quilted, draped, nailed, hog-ringed. Rigids can be fabricated with woodworking tools.



Or . . . use pre-molded shapes, ready to set in place.

Or . . . foam-in-place by spraying urethanes to adhere to vertical, even overhead planes.

Or . . . pour foam-in-place urethanes to fill voids or encapsulate difficult shapes. Use them in potting or deep casting.



Or . . . use urethanes in strength-with-lightweight sandwich constructions.

No other material solves so many problems so simply as URETHANES!

based on
National Aniline's NACCONATES®

Their amazing versatility of form and wide range of usefulness are well matched by the many labor-saving ways urethanes can be fabricated. Only a few of the possibilities are shown here!

However you use them you'll find urethanes easy to handle, economical and full of new design ideas in cushioning, packaging, vibration isolation, shock absorption or insulation against heat, sound and electrical loss.

As suppliers of NACCONATE® Diisocyanates, basic urethane components, our application laboratory has developed much valuable information which is yours for the asking. A brief note, on your company letterhead, outlining your particular interest will enable us to be specific in reply.

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Portland, Ore. Providence San Francisco Toronto

CIRCLE 165 READER SERVICE CARD →

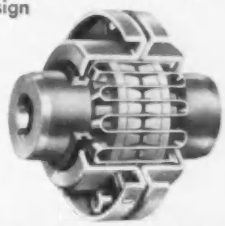
How one FALK coupling saved more than $1,000 per month

Pictured below is a Falk Steelflex Coupling assembly which connects a 2500 hp motor to a reduction unit driving an 18" bar mill in a Midwestern steel plant. This coupling replaced another type which broke repeatedly, causing maintenance expense averaging $1,000 a month—plus costly production losses. Since installation of the Falk Coupling, with its controlled torque mechanism that disengages when a predetermined overload occurs, there has been no interruption of production. Savings in maintenance and in lost production time are well in excess of $1,000 per month...dramatic proof of the importance of coupling design!

Long coupling life is not the sole criterion of coupling performance. Inadequate shaft couplings may be the cause of bearing damage or shaft breakage on your machines. If so, a change to Falk Steelflex will give two-fold protection to your connected machines: (1) compensation for reasonable degrees of shaft misalignment, and (2) torsional resiliency to reduce peak loads as much as 30%. These advantages are as important to you as the long service life of the Falk Steelflex Coupling itself.

Falk Steelflex Couplings, in types and sizes to meet virtually all industrial applications, are promptly available from distributor, warehouse and factory stocks. Consult your Falk Representative or Authorized Falk Distributor.

Basic **Type F**—cutaway view showing exclusive grid-groove design



THE FALK STEELFLEX
...a truly flexible coupling

Here is the coupling that has all the strength of steel, yet is truly flexible. More *than a million* have been bought for industrial service of many kinds.

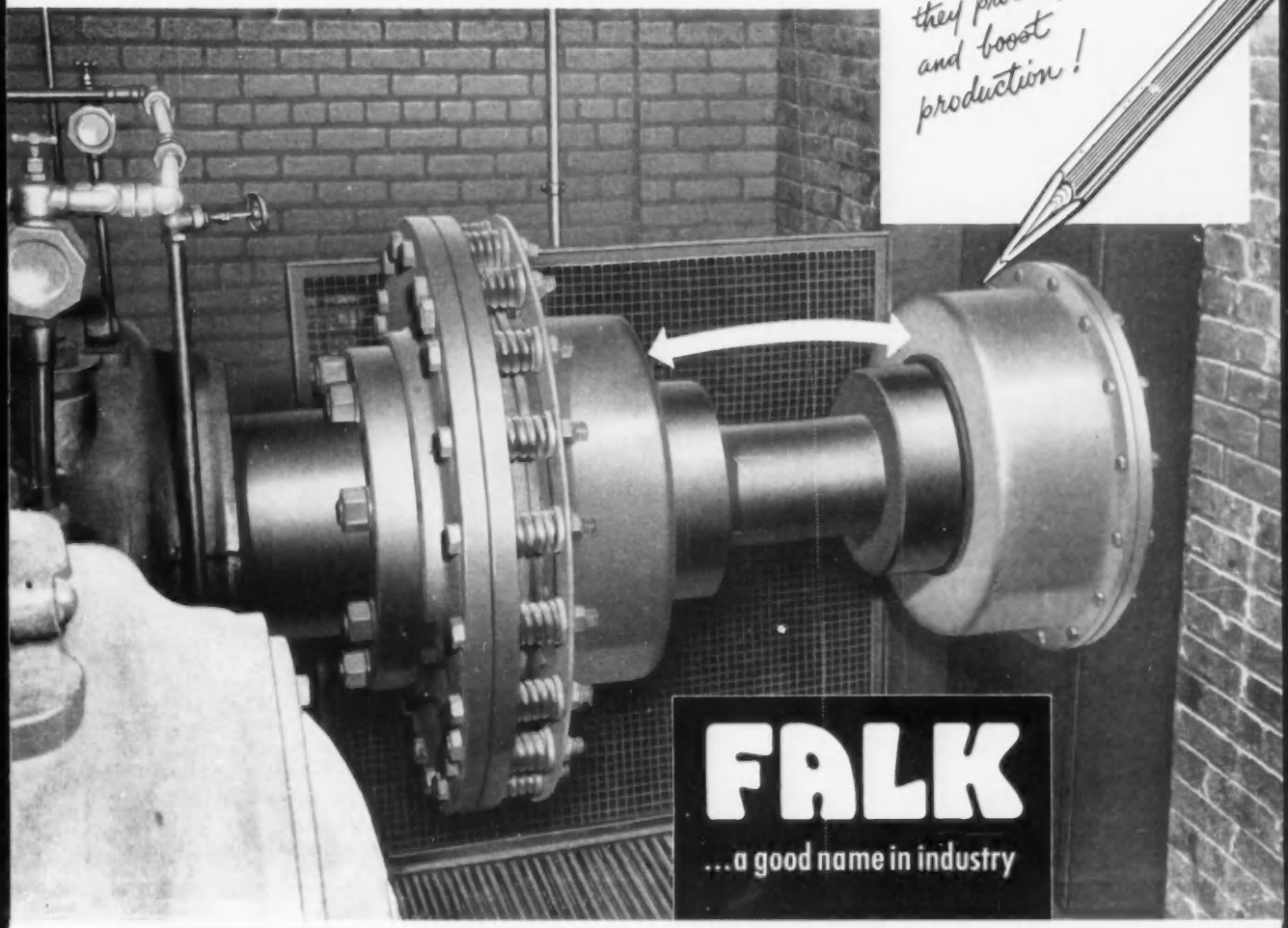
Because, in addition to its inherent superiorities of design, the Type F Steelflex can be used horizontally or vertically without modification or special parts, it has been adopted as standard in many plants—and by many designers and manufacturers of industrial equipment...Write for Bulletin 4100.

THE FALK CORPORATION, MILWAUKEE 1, WISCONSIN

MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in many principal cities

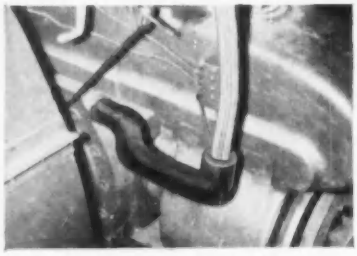
Good couplings not only connect machines; they prolong machine life and boost production!



How to keep consistent temperatures and/or prevent condensation on warm or cold lines

Send for free Bulletin

Rubatex Tubing can be slipped onto piping before it's installed on air conditioning unit or system.



Flexible tubing can be easily installed onto piping with swings and bends up to 180°.

Slit tubing with adhesive applied fits snugly onto joint.

Complete data, applications and specifications on RUBATEX Closed Cellular Tubing Insulation—specially developed tubing for OEM, commercial, industrial and residential heating and cooling lines, chilled water and other cold lines where service conditions are moderate.

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Name_____

Type of Business_____

Proposed Application_____

Attach to your letterhead and mail this coupon for your copy of new Rubatex Tubing Bulletin today!

quick-make and quick-break plus an intermediate position where both working circuit and signal circuit are tripped. There are two normally open and normally closed auxiliary circuits. Manual release is provided for equipment cutoff from main power supply. **E-T-A Products Co. of America, 5085 N. Elston Ave., Chicago 30.**

Circle 18, inside back cover

Nickel-chrome alloy rivets . . . in tubular and solid form are said to retain strength and resist oxidation to 1800 F, have uniform metal quality, crack-free heads and rigid adherence to dimensional requirements. **John Hassall, Inc., Westbury, N. Y.**

Circle 19, inside back cover

Corrosion-resistant air muffler . . . eliminates objectionable noises. It is not affected by heavy concentrations of moisture or oil in pneumatic system. Muffler has been tested in pressures exceeding 100 psi and can be mounted on any valve discharge port or piping with standard pipe threads. Furnished with both male and female pipe threads in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$ and $\frac{1}{2}$-in. NPT sizes. A $\frac{1}{4}$ NPT unit is $\frac{7}{8}$ in. dia x $2\frac{1}{2}$ in. body length. **Design Aids Co., 328 S. 6th St., Newark 3, N. J.**

Circle 20, inside back cover

Panel meter . . . has moving coil mechanism said to achieve a higher flux level and more symmetric flux distribution than core or external

(Continued on page 118)

What every designer should know about

FACE GEARS for Angular Drives

FACE GEARS have distinct advantages which the designer should know. They can be spur or helical, "on-center" or "off-center." The mating members are pinions. Both are generated on Fellows Gear Shapers by cutters having involute teeth.

Utilization of face gears results in a simple, compact design that can be economically manufactured and assembled.

Consider all these advantages:

- quality cutting at low cost
- easier and lower cost assembly
- no appreciable thrust
- pairing for reversal of direction
- tooth bearing not affected by axial displacement of pinion

GET ALL THE FACTS:

Information on the design and cutting of Face Gears is free for the asking. Just write to:

THE FELLOWS GEAR SHAPER COMPANY
78 River Street, Springfield, Vermont

Branch Offices:
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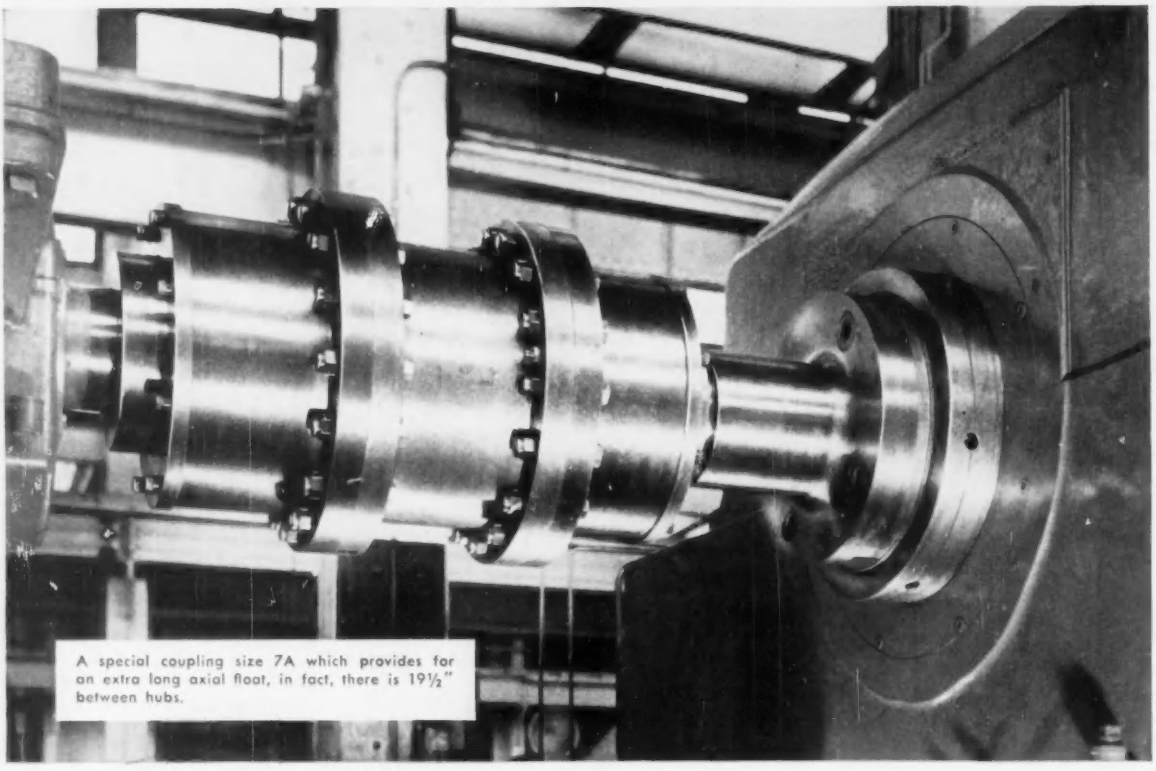
150 West Pleasant Ave., Maywood, N. J.
5835 West North Avenue, Chicago 39
6214 West Manchester Ave., Los Angeles 45

THE PRECISION LINE **Fellows** *Gear Production Equipment*

CIRCLE 167 READER SERVICE CARD

SPECIAL COUPLING PROBLEMS



A special coupling size 7A which provides for an extra long axial float, in fact, there is 19½" between hubs.

SOLVED

at JOHN WALDRON

From time to time, manufacturers are faced with special power transmission problems which cannot be handled by standard couplings. Sometimes they need a coupling for exceedingly high speed drives, sometimes a coupling for very large diameter shafts and for other special applications.

John Waldron, which is well known for its ability to produce high quality couplings also makes excellent special couplings to customer requirements. In the past, Waldron has made couplings that turn at speeds over 50,000 RPM, couplings which can take over 45,000 HP and couplings for particular applications such as continuous lubricated couplings, spacer types, shear pins, cut-outs and couplings for many other special installations.

If you have a particular power transmission problem that needs a special coupling, call or write the John Waldron Corporation in New Brunswick, New Jersey. Their long experience in designing, and manufacturing couplings for special problems, may have already solved your problem for you.

JOHN **WALDRON** CORP.

A unit of J. O. Ross Engineering Division
Midland-Ross Corporation
New Brunswick, New Jersey

STOPPED!

LOST *10,000 man-hours*

and your high-paid help talks TV

Stopped . . . because automatic control circuits and operating elements were not designed on the modular basis, with Cannon quick-disconnect electrical connectors at vital points.

But it could have been rolling in seconds or minutes! If only the circuitry had been arranged on the modular basis so that essential elements of the automatic control and operating system could be disconnected quickly . . . and complete, operable spare components inserted at a moment's notice. The units in trouble could have been repaired properly, too, at leisure . . . by trained personnel, at the right place, with the right facilities. Production could have gone on . . . thousands of man-hours and thousands of dollars saved . . . merely by the use of quick-disconnect components.

Are the controls in your electrical or electronic product designed on the modular basis? How about your production line? Will minor failure cause breakdown? Or do you need Cannon Connectors? Cannon makes over 27,000 different electrical connectors. If one of these does not meet your requirements, we'll design and make the electrical connector you need. Write today! Cannon Electric Co., 3208 Humboldt St., Los Angeles 31, Calif. Please refer to Dept. 106.

Send for explanatory material on how modular designs can save dollars.

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CANNON ELECTRIC

Where Reliability for Your Product is Our Constant Goal

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INDUSTRIAL DISTRIBUTOR

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Roller Chains and Sprockets

For the finest in roller chain and the best of service . . . call your local Acme Industrial Distributor whenever you need any kind of chain information, parts, or engineering service.

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Write Dept. 1-W for new 100-page Illustrated Catalog, including new engineering section showing diagrams of 36 methods of chain driving.

Call **ACME** for Service

Acme Chain Corporation

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COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

magnet types. Self-shielded mechanism provides tracking that can be held to ½% of full scale, when plotted linearly or with a protractor reference for deflection angles up to and including 100°. This permits special instrument scale to be prepared without regard to meter error curves. Meter occupies panel space of conventional 4½-in. units and the mounting space of 3¼-in. instruments, yet provides increased scale length. Front housing is heavy gage brass finished in satin chrome or a choice of colors. **Marion Electrical Instrument Co., Genier Field, Manchester, N. H.**

Circle 21, inside back cover

Stroke control valve . . .

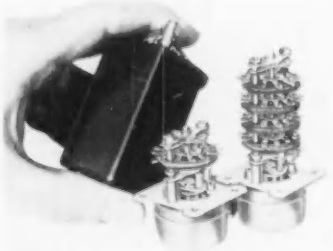
is said to eliminate creeping of hydraulic double-acting cylinders, regardless of wear or leakage in manual control valves. It may be placed in any desired position in hose lines between manual control valve and cylinder. Valve is automatic and self-operating. Pump must be running to provide activating pressures for the valve. **Regent Jack Mfg. Co., Inc., 11905 Regentview Ave., Downey, Calif.**

Circle 22, inside back cover

Subminiature dc motor . . .

has neither brushes nor commutator. Rotating assembly consists of an Alnico disk supported on a stainless steel shaft running in ball bearings. Stationary field coils furnish rotative flux and are commutated by transistors. Subfractional watt instrument motor weighs 2¼ oz complete with reduction gear and occupies about 3 cu in. The 6-v model draws 6 milliamp at rated voltage and will operate reliably on power inputs as low as 20 milliw. Output torque is about 10 oz-in. at 1 rpm. **Brailsford & Co., Inc., 670 Milton Rd., Rye, N. Y.**

Circle 23, inside back cover



Rotary selector switch . . .

holds up to four 12-position wafers for miniature design applications. Switch is actuated by rotary solenoid weighing 2 oz; 1⅛ in. dia. Indexing shaft, ratchet mechanism and four wafers make up

(Continued on page 122)

No matter where your customers buy Macoma

Other Outstanding Shell Industrial Lubricants

Shell Tellus Oils—for closed hydraulic systems

Shell Alvania Grease—multi-purpose industrial grease

Shell Turbo Oils—for utility, industrial and marine turbines

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Shell Dromus Oils—soluble cutting oils for high-production metal working

Shell Voluta Oils—for high-speed quenching with maximum stability

Its performance and name are the same around the world

Shell Macoma Oils are premium quality, fortified extreme pressure gear oils. They provide superior high-load-carrying capacity and are particularly effective where overloading, severe shock-loading or general heavy-duty conditions exist.

Macoma* Oils have these added built-in benefits: excellent resistance to oxidation, great adhesiveness, rapid separation from water. They are non-corrosive, non-foaming and have high stability in storage.

The world-wide availability of Macoma Oils is assurance that your customers abroad will get the same performance from your equipment that your domestic customers rely upon. For complete specifications, write Shell Oil Company, 50 West 50th St., New York 20, N. Y. or 100 Bush St., San Francisco 6, California.

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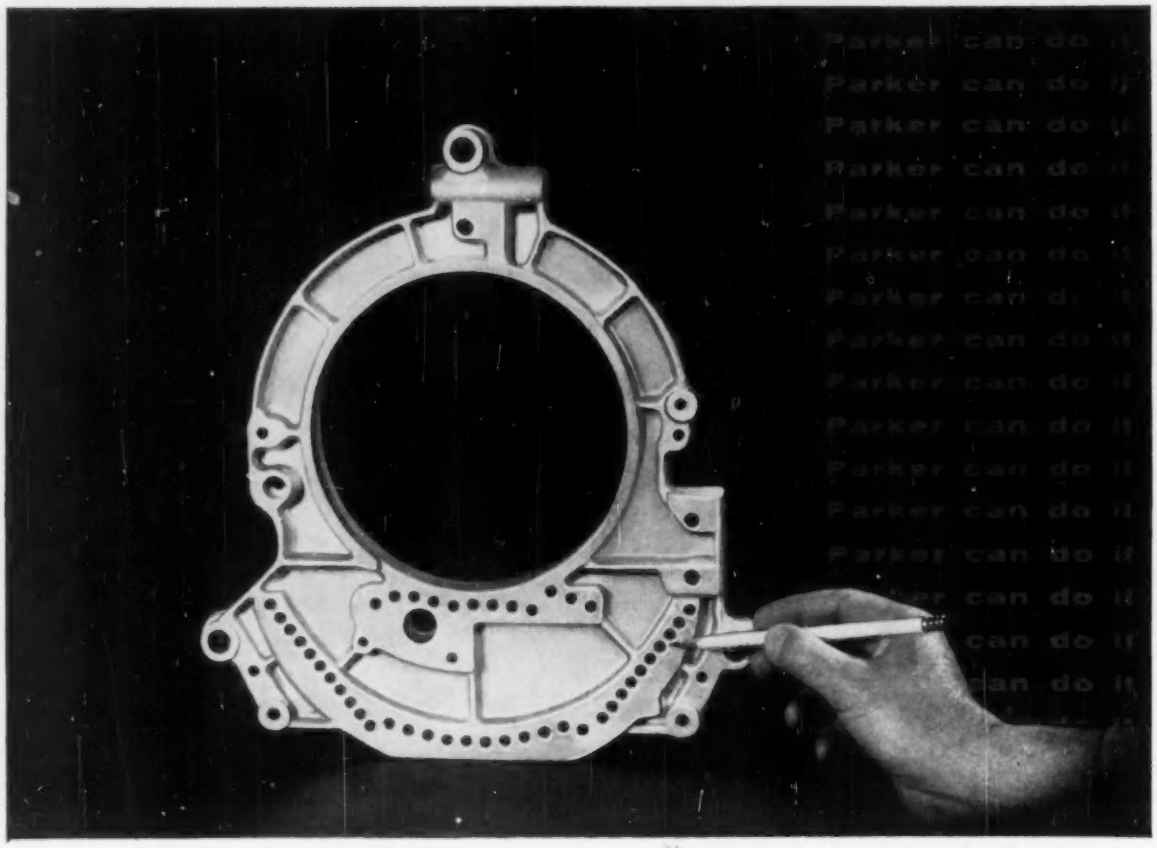
SHELL MACOMA OIL

SHELL



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These close tolerance holes could have cost more than the part itself. Actually, *they cost practically nothing!* Parker-engineered die casting makes the difference. By means of precision coring, the holes are cast to exact diameter and location . . . a bonus in the low unit cost of producing the complete part. Just think of the savings compared with other production methods requiring finish machining.

The creative engineering approach that made these savings possible has been the hallmark of Parker service since 1906. It is the plus factor that is never figured into a Parker estimate. If you are a Parker customer, you know this is so. If you are not, you can profitably prove it to yourself by consulting the nearest Parker sales engineer on your next component part requirement.

Parker White Metal Company • 2153 McKinley Ave., Erie, Pennsylvania

PARKER

high pressure die castings in ALUMINUM • ZINC POWDERED METAL PARTS

CIRCLE 173 READER SERVICE CARD →

Avoid costly down-time caused by electrical control failure....

Nothing is more frustrating to the production man than downtime caused by the failure of a minor component. An $85,000 machine tool down because of a failure of a limit switch can be as expensive as if it were caused by a main bearing burnout. National Acme's electrical controls are designed by machine tool designers and built as machine tools are built. That means extra ruggedness, extra dependability but it does not mean extra cost.

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Oil-tight, water-tight, dust-tight. Built with heavy duty silver alloy contact points, over-size terminal screws, superior dielectric materials. For full information ask for a free copy of Bulletin ECS-56.

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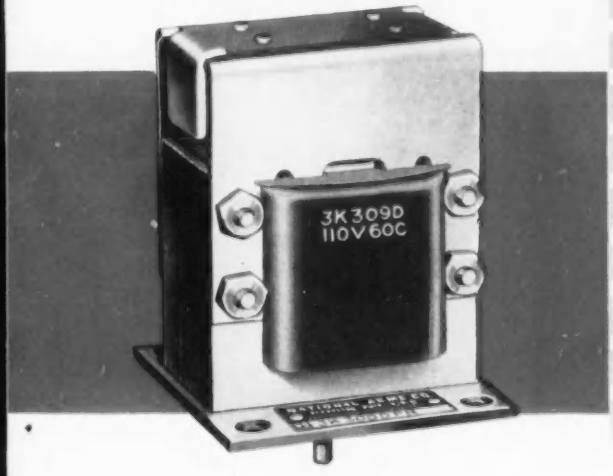
A full line of heavy duty Limit Switches designed originally for machine tool installation but now used wherever extra dependability, extra ruggedness and long life are required. For full information ask for a free copy of our Bulletin EM-51.



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A full line of standard and custom made Solenoids for AC or DC use. Push or pull types with capacities up to 25 lbs. Bulletin EM-52A provides information on the application, design and installation of Solenoids. Write for your free copy today.

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THE SENSATIONAL BREAK-THROUGH IN DRY BEARING TECHNOLOGY
• A porous-bronze, steel-backed bearing material, impregnated with a permanent, solid, T.F.E.* fluorocarbon resin-lead lubricant.
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• Same performance at 328° below zero as at 536° above.
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• Immune to solvents, alkalis, corrosive chemicals, abrasive atmospheres.
Consider what this new bearing material can mean to your products. Ask your bearing manufacturer or write for complete brochure to Special Products Department, UNITED STATES GASKET COMPANY, Camden 1, N. J.
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United States Gasket Plastics Division of GARLOCK

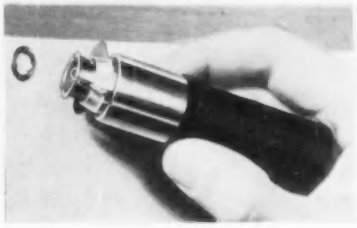
remaining weight for a total of 3¼ oz. Max dimensions are 2¹³⁄₁₆ x 1⅞ x 1⅞ in. Operating voltage is 3 to 300 v dc and minimum pulse length is 20 millisec. Meets applicable environmental tests for vibration, ambient temperature range, shock and corrosion. Performs such switching jobs as stepping, counting, programming, circuit selection and homing. Remotely controlled, it can be self-stepped or externally impulsed. Service life is said to be 500,000 steps. **G. H. Leland, Inc., 123 Webster St., Dayton 2, Ohio.**

Circle 24, inside back cover

Reinforced plastic housings . . .

for components or assemblies are offered in any desired color (which is integral in plastic itself). Dimensions and other specifications to order. **Fischer & Porter Co., 739 Jacksonville Rd., Hatboro, Penna.**

Circle 25, inside back cover



Tacking device . . .

places tacks and reclaims them. The 4-in. tubular tool affixes paper to drawing boards, stores its own tacks in a refillable magazine, and removes the three-pronged tacks for reuse. Tacks are designed for wood, cork, fiberboard and linoleum. The 4-oz device holds up to 60 tacks in magazine. Made in Switzerland. Price is $5.95 with a 14-day money-back guarantee. **ColorFIX Import Co., 1409 Willow St., Minneapolis 3.**

Circle 26, inside back cover

Automatic voltage regulator . . .

can absorb high overload surges while delivering undistorted ¼% true rms voltage regulations. Designed for 115-v operation, unit stabilizes line voltage variations over a 10 or 20% range. When operating

(Continued on page 127)

HOW IT WORKS

1. Stab pipe ends into factory assembled Dresser Fitting.

2. Tighten end nuts—takes only a few seconds.

3. And you're through! A permanently tight, flexible joint.

There is one simple way of joining equipment piping

Dresser® Compression Fittings enable you to design equipment with a complexity of piping . . . *without* the assembly, maintenance, and take-down problems of other pipe joining methods.

No elaborate equipment required for installation . . . no skinned knuckles or fumbling in tight quarters. A few turns of a simple hand wrench and you've got a *permanent, leak-proof* joint. The special compound Dresser gasket absorbs vibration, prevents pipe and equipment failure. The one simple, reliable way of joining pipe is the Dresser way.

Dresser's staff of highly qualified engineers may well be able to help you cut costs in the designing stage of your product. It will pay you to talk to them.

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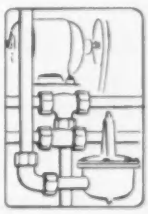
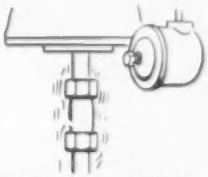
WHAT IT DOES

SAVES TIME–
No pipe threading or exact pipe lengths.



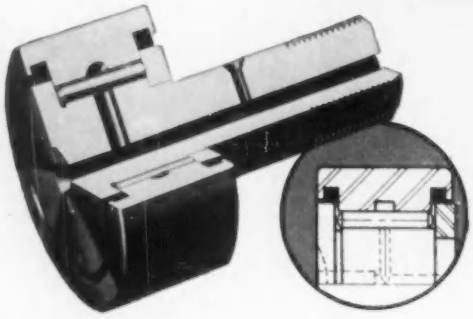
SIMPLIFIES INSTALLATION–
Permanent, leak-proof joints even with misaligned pipe (up to 6° deflection at each joint).



ABSORBS VIBRATION–
Prevents stresses that often cause pipe and equipment failure.

BEARING TIPS by McGill

sealed CAMROL® bearings lock out contamination in critical cam follower applications

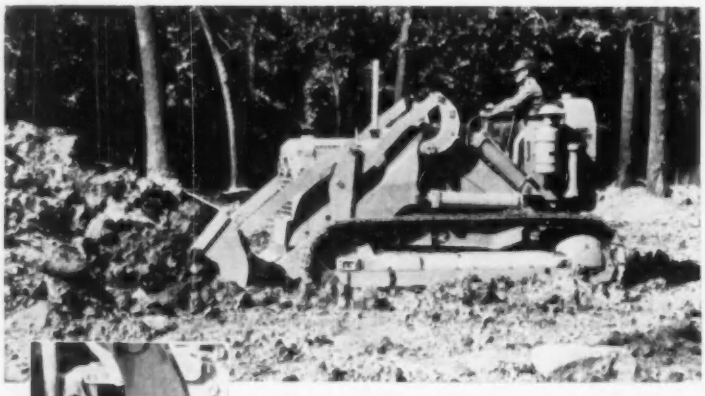


Now Sealed and Prelubricated

The new SCF series of the famous CAMROL cam follower completely seals out dirt, chips, moisture, etc. — an important advantage where the life of an ordinarily open mounted cam follower can be materially increased with adequate protection against contamination. Also the sealed bearing is pre-lubricated with provision made for easy re-lubrication, if desired, through either end of the stud.

Specially treated synthetic seals are contained in the outer race undercuts over the stud flange and roller retaining washer. For added protection, all external surfaces of the bearing are treated to provide a corrosion resistant, black ferrous oxide surface.

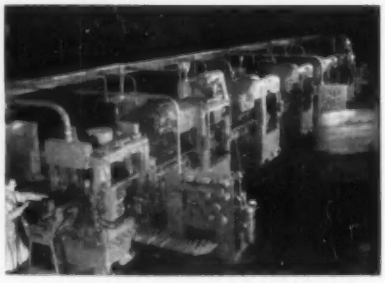
These same advantages are available in the SCYR sealed series Cam Yoke Roller (without stud). Specify CAMROL bearings with the built-in seals that preserve cam follower dependability in critical cam action, support or track roller application.



Built-in seals protect and preserve CAMROL® bearings from contamination in CATERPILLAR-built TRAXCAVATORS®

McGill SCF series sealed CAMROL bearings provide the cam action that positions the bucket of the No. 977 Traxcavator unit at the selected digging angle. Mounted on bell crank arms that are actuated by contact with a cam shoe on a hydraulic cylinder linkage, these bearings are operating in the open and exposed constantly to dust, dirt and moisture. External surfaces have a black ferrous-oxide finish to prevent corrosion. These sealed McGill cam followers eliminate the need for relubrication and maintenance after installation. Caterpillar uses other McGill bearings including twelve CYR series cam yoke roller bearings in the flywheel clutch.

378 sealed CAMROL® bearings guide engine blocks in INGERSOLL automatic milling machine

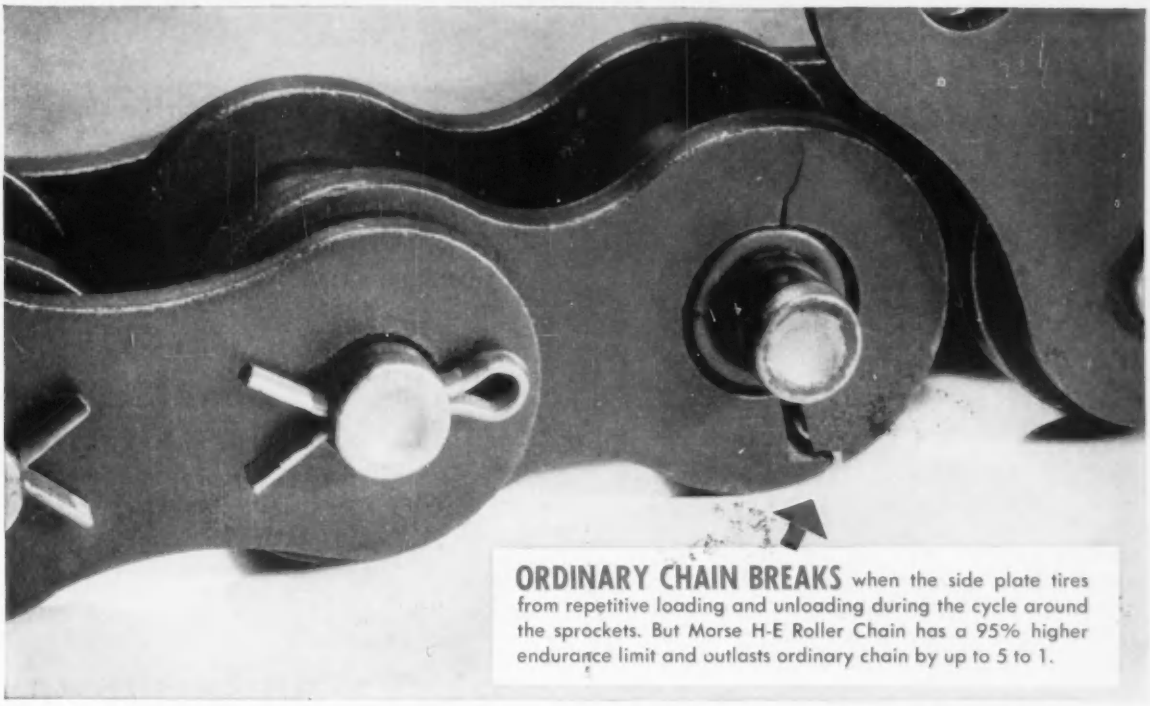


The sealed CAMROL bearings used in this machine, guide cylinder blocks during transfer through various milling, boring and drilling operations. The bearings, used in place of guide bars, eliminate surface scratching of the 200 to 300 pound blocks which are transferred at speeds up to 400 feet per minute. Blocks are processed at the rate of 95 per hour. Ingersoll reports freer movement, accuracy of positioning and materially longer bearing life due to the new design that seals metal chips out of the bearings.

Insure performance with McGILL®

MULTIROL® GUIDEROL® CAMROL®
Precision Needle Bearings

McGILL MANUFACTURING COMPANY, INC., 201 N. LAFAYETTE ST., VALPARAISO, INDIANA



ORDINARY CHAIN BREAKS when the side plate tires from repetitive loading and unloading during the cycle around the sprockets. But Morse H-E Roller Chain has a 95% higher endurance limit and outlasts ordinary chain by up to 5 to 1.

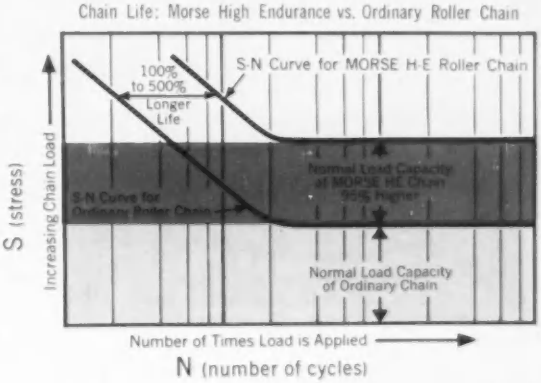
"Tired Metal"... the bane of chain now licked by MORSE H-E

Morse H-E Roller Chain has up to 500% longer service life . . . cuts replacement and labor costs

The unretouched photograph shows what happens to chain when the metal fatigues. But now a special Morse process has licked the "tired metal" problem. It gives Morse H-E Roller Chain 95% higher endurance limit . . . and up to 500% longer service life.

The special process means Morse H-E Chain costs about 10% more. But that's a small price to pay for a heavy-duty chain that can save you thousands of dollars annually in replacement costs, downtime, and wasted man-hours.

For more information on the chain that licked the "tired metal" problem once and for all, see your local Morse Distributor. Or write: MORSE CHAIN COMPANY, Dept. 4-68, Ithaca, New York. Export Sales: Borg-Warner International, Chicago 3, Illinois.


Chain Life: Morse High Endurance vs. Ordinary Roller Chain
S-N Curve for MORSE H-E Roller Chain
100% to 500% Longer Life
Normal Load Capacity of MORSE HE Chain 95% Higher
S-N Curve for Ordinary Roller Chain
Normal Load Capacity of Ordinary Chain
S (stress)
Increasing Chain Load
Number of Times Load is Applied
N (number of cycles)

Red area: Under these chain loads, fatigue will break ordinary chain . . . but *not* Morse H-E.

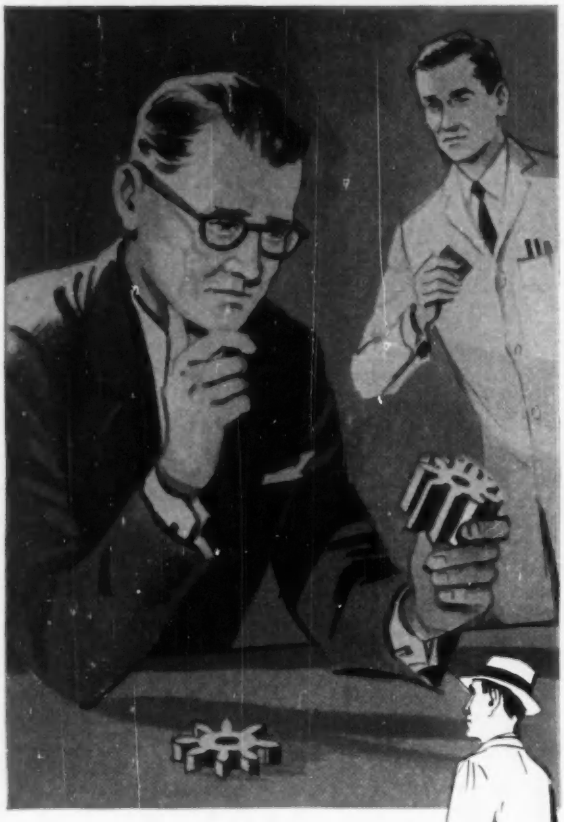
White area: Under these loads, fatigue will break ordinary chain and Morse H-E . . . but Morse H-E will have operated 100% to 500% longer.

IN POWER TRANSMISSION THE TOUGH JOBS COME TO **MORSE** BW

"Trademark

REMEMBER: Only Morse offers you all four of these basic drives: Roller Chain, Silent Chain, Hy-Vo®, and "Timing"® Belts.

Reject rate too high?



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MD Metallurgist
IN THE PICTURE

The MD man who calls on you is a competent salesman. He is part of an industry that has grown to serve a significant new technique of manufacture — fabrication of precision parts from powdered metals.

He is backed by a company which, for the past 42 years, has pioneered in the development of the right powders for the right job, and which has always considered that solving customers' problems is a fundamental obligation.

Our laboratory, built and completely equipped for customer service, is staffed by "MD Metallurgists" who have also grown up with the industry, and have contributed to its progress. This "plus value" is always available to MD customers. Your problems are our problems.

METALS DISINTEGRATING COMPANY, INC.
GENERAL OFFICES: Dept. N, Elizabeth 8, N. J.

How to keep informed on the "with what" part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL PUBLICATIONS

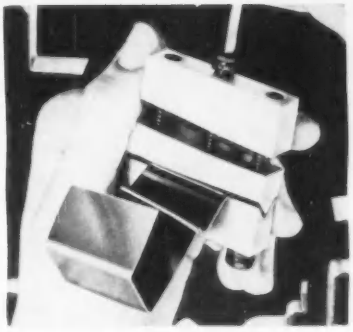
within a 10% correction range, it provides a 12-kva output with output current of 100 amp. Response speed is 5 and 10 v/sec for the 10 and 20% ranges, respectively, and total correction time is 4 sec. Performance is said to be independent of load power factor. Equipment is portable and cabinet permits bench or relay rack mounting. **Tel-Instrument Electronics Corp., Dept. P, 728 Garden St., Carlstadt, N. J.**

Circle 27, inside back cover

Pressure transmitter . . .

with gasproof electrical connection handles most gases and corrosive media. Pressure cavity has low volume resulting in fast response to dynamic pressures. Operates in ambient temperatures of −65 to 250 F in pressures of 300 to 10,000 psi. A ¼ in. NPT taper-threaded pipe connection is substituted for the standard connector. Linearity is 0.25% and hysteresis is 0.5%. An 18-in. length of four-conductor cable is sealed within the threaded connection with potting compound, providing a positive seal. **Taber Instrument Corp., North Tonawanda, N. Y.**

Circle 28, inside back cover



Midget portable bender . . .

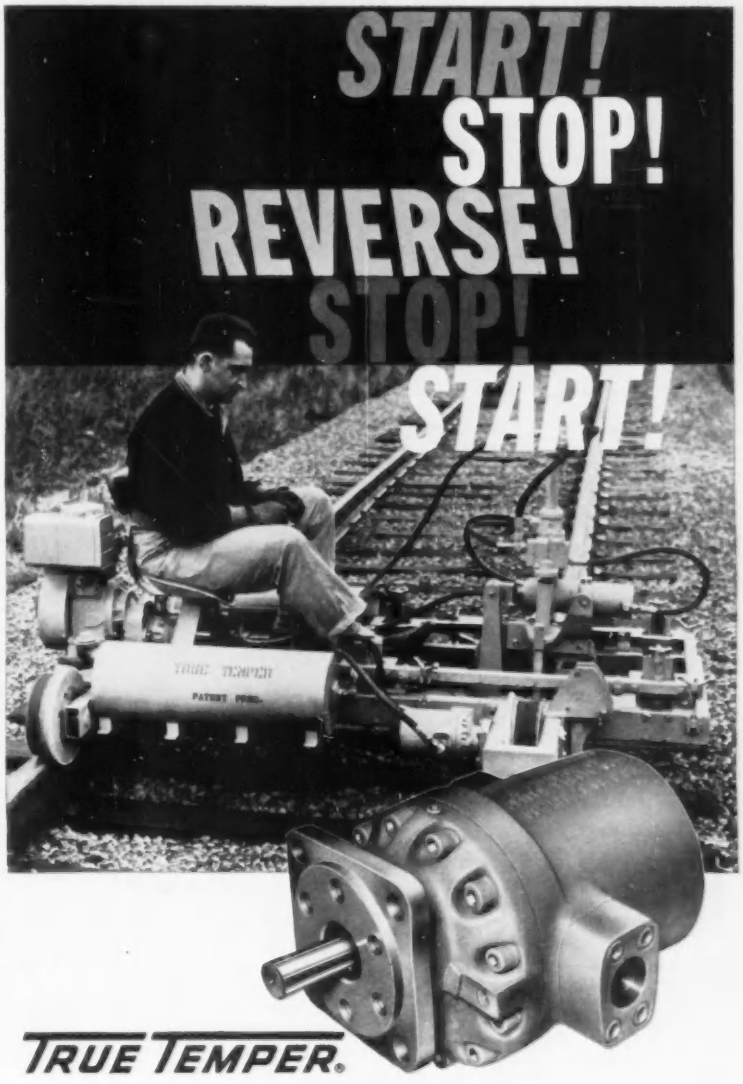
is a hand tool that bends strip of cold-rolled steel, ¼ in. thick, into almost any shape or form. Exerts up to 2000 psi to form metals against its interchangeable curve and angle dies. It bends wire, brass, aluminum, steel or other metals up to ¼ in. thick and 1¼ in. wide. Retails for $4.95. **Shaf Mfg. Corp., 1020 Germantown Ave., Philadelphia 23.**

Circle 29, inside back cover

Contour reproduction . . .

on specially coated glass of exterior, interior, top and bottom halves of a die and mating parts is possible with a new contour transcriber. The reproduction, called a trace, is measured by determining X-Y coordinates on conventional contour projectors: by comparing with a grid and by comparing to a master outline or reticle.

(Continued on page 128)



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BERRY Motors

High torque, instant reversibility, small size with light weight—these Berry Motor characteristics contribute to the 500 to 700 anchor per hour speed of the *True Temper Hydraulic Rail Anchor Machine*. Direct-connected to two drive wheels, the motors produce immediate response, speeds to 20 mph and excellent performance on grades.

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AC MOTORS

1/1600 H.P. to 1/35 H.P.

MODEL B
1/80 H.P. to 1/35 H.P.
4-pole, 4-coil shaded pole
AC induction type

...for a standard line of motors adaptable to hundreds of applications

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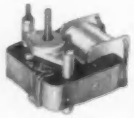
Fractional H. P. Motors

General Industries' standard line of motors is adaptable, with slight variations, to literally thousands of applications. This means that your motor requirements can most likely be met without additional time-consuming engineering.

If you are currently using fractional horsepower motors, or are planning a product that calls for their use, phone or write General Industries. We'll gladly make recommendations—without obligation.



MODEL A
1/500 H.P. to 1/45 H.P. 2-pole
shaded pole
AC induction type

MODEL D
1/90 H.P. to 1/45 H.P. 4-pole,
4-coil shaded pole
AC induction type

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THE GENERAL INDUSTRIES CO.

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Handles contours up to 8 x 18 in. long. A companion viewer facilitates measurement and evaluation of contour traces. It has a grid glass, illuminated from below by a special cold neon tube. Scale readings to 0.0001 in. are possible, using grid and associated measuring micrometer. Transcribers and viewers simplify many difficult contour inspection problems, gathering and classifying of engineering data, production of duplicate gages and tooling and checking of dies and molds for wear. **Optical Gaging Products, Inc., 26 Forbes St., Rochester 11, N. Y.**

Circle 30, inside back cover

Hydraulic test instrument . . .

for tensile, compression, shear and transverse deflection will test up to 160,000 psi, using 0.252-dia test samples. Smallest graduations of 100 lb on dial can be read to 25 lb with fair accuracy. The 6-in. dial face is calibrated 0 to 8000 lb in divisions of 100, 500 and 1000 lb. Equipped with adjustable hydraulic compensator for room-temperature setting. Instrument can be operated in horizontal or vertical position, for recording horizontal thrust. Instrument weighs 47 lb. Price is $420, FOB factory. **Truck Scale & Research Corp., P. O. Box 1047, St. Petersburg 5, Fla.**

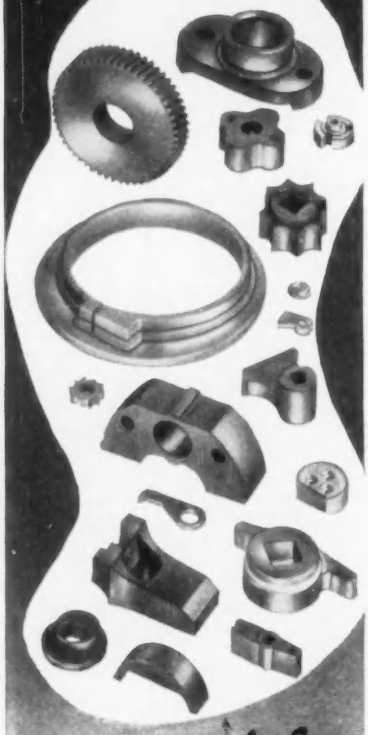
Circle 31, inside back cover

Shifting of phase . . .

in a circuit is possible by inserting this unit into the circuit, rather than piecing wires and components together. Phase can be changed fast (in seconds) over the range from 0 to 180°. Unit is 6½ x 3¾ x 3 in. and weighs 1.5 lb. Input can be as high as 30-v rms and frequency is 25 to 10,000 cps. A floating input transformer coupled to phase-shift circuitry eliminates common ground problems. Impedance is said to be about 15 k under usual conditions. Output voltage has same amplitude as input. **American Measurement & Control, Inc., 240 Calvery St., Waltham, Mass.**

Circle 32, inside back cover

Maintain Quality . . .



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WITH POWDERED METAL PARTS BY

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Originators of

SINTERED HELICAL GEARS. HIGH DENSITY, PRECISION STRUCTURAL PARTS — POLE PIECES, SPUR GEARS, CAMS, RATCHETS, PAWLS . . .

Merriman offers you highest possible quality, perfect fit and dimensional accuracy at important reductions in cost. All tools and dies are made in our own shops. Complete design and engineering staffs are available for consultation.

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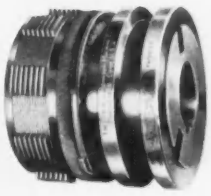
if **BRAKES** are your problem

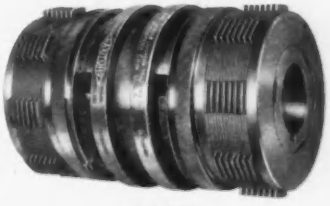
let's talk

Maxitorq

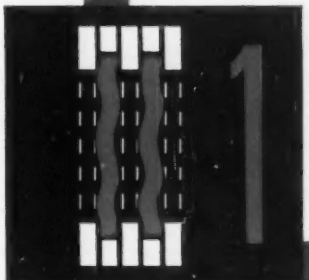
the floating disc clutch that is equally efficient as a **BRAKE**



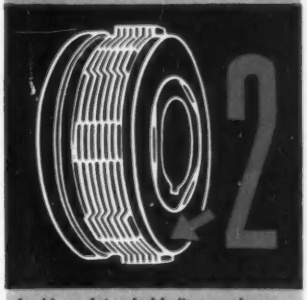
Single



Double



Unique separator springs completely separate floating discs when in neutral, preventing drag or heating.



Locking plates hold discs and separator springs in correct and complete assembly. Easily installed, easily serviced.

Simple manual adjustment by rotating this locked ring. Requires no special tools.

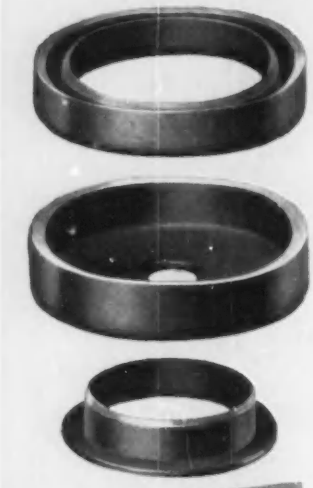
Here is a practical and efficient answer to the majority of brake problems in machine tool and industrial machinery drives, because the service-proved advantages of MAXITORQ Floating Disc design apply equally to the use of these dependable units *either as clutches or brakes!*

These advantages include compact, simple and rugged construction, ideally suited to "designed-in" applications. With patented MAXITORQ separator spring design, engagement and disengagement is always positive and complete, with no drag or heating in neutral. MAXITORQ Brake or Clutch Units are furnished complete, ready to install, with simple manual adjustment—no special tools required.
Can be used either WET or DRY and assure long, trouble-free service. Let our Engineering Department help you solve either BRAKE or CLUTCH problems this proved way.
Send us an outline of your needs. Write Dept. PE-6.

The Carlyle Johnson Machine Co.

MANCHESTER • CONNECTICUT

SCJ30



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in Viton A, Vyram, Polyurethane, and other unusual elastomeric materials having excellent resistance to many petroleum oils, synthetic lubricants, fuels, phosphate and silicate ester fluids—in a temperature range of —40° to + 500°F.

LINEAR—specialists in close-tolerance molding in all of today's modern polymers . . . in both fabric reinforced and homogeneous materials.

These are low friction seals. For further help, call the LINEAR engineer.

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CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover. For those catalogs and bulletins available only when requested on company letterhead, see page 137.

MANUAL REMOTE VALVE CONTROLS—Bulletin 5811, 20 pp. Gives design information on flexible shaft valve controls including valve couplings and remote operating terminals. 300° swivel-geared joint is also shown. Stow Mfg. Co., 426 Shear St., Binghamton, N. Y.

Circle 33, inside back cover

MAGNETIC CLUTCHES—Bulletin M-101-A, 8 pp. Tells how and where electrically operated units are used. Gives dimensions, torque ratings, power requirements, heat dissipation characteristics, torque buildup and decay time, and suggested control circuits. Cutaway drawings show operation and construction. Application drawings show typical installations. Fawick Airflex Div., Fawick Corp., 9919 Clinton Rd., Cleveland 11.

Circle 34, inside back cover

ELECTRO CLUTCHES—Catalog 6304-1A, 20 pp. Provides application reference material. Gives examples of applications, provides data and specifications on clutches and summarizes general application information. Sections on each of six designs furnish cutaway perspective drawings, 2-dimensional drawings, application notes and specifications, and prices on sizes available. Transformer and Rectifier Div., I-T-E Circuit Breaker Co., 19th and Hamilton Sts., Philadelphia 30.

Circle 35, inside back cover

INTEGRAL AND FHP ELECTRIC MOTORS—Catalog, 20 pp. Gives specifications, dimensions and outputs of motors. With exploded views, photos, dimensional drawings and prices. Newman Electric Motors, Inc., 357 Wilson Ave., Newark 5, N. J.

Circle 36, inside back cover

METAL POWDER PARTS—Brochure, 8 pp. Outlines possibilities and requirements. Includes design pointers. Compacted Metals Corp., 99 Greenwood Ave., Waukegan, Ill.

Circle 37, inside back cover

PILOT LIGHTS—Digest form L-161, 16 pp. Condensed technical information on pilot light assemblies and appropriate lamp types housed therein. Units are illustrated life-size and described with data such as lamp and required voltage, mounting information, insulation, type of lens holders, lenses and colors, terminal types, finishes. In some groups, charts and circuit diagrams are given. Dialight Corp., 60 Stewart Ave., Brooklyn 37, N. Y.

Circle 38, inside back cover

SLIP CLUTCHES AND COUPLINGS—Bulletin SC2, 4 pp. Depicts typical installations. Explains how slip clutches and couplings extend life of machinery. Lists range of sizes and styles. Hilliard Corp., Elmira, N. Y.

Circle 39, inside back cover

INVESTMENT CASTINGS—Data file, 4 pp. Contains charts showing comparative tolerances, sections, finishes, tooling time, relative costs of all casting processes. Simplification of parts is discussed and available metallurgical services are outlined. Rode, Inc., 3 Green St., Woburn, Mass.

Circle 40, inside back cover

HYDRAULIC CYLINDERS — Bulletin JH-104N, 32 pp. Specific information on cylinders for 500 to 2500-psi service and 3000 to 5000-psi service, and general information on cylinders. This includes charts and descriptive data on column strength, piston rod deflections, acceleration, factors of safety, cylinder forces, pressure losses in pipes, factors in selection. A 4-pp center spread folds out to give mounting and dimensional data on cylinders. Miller Fluid Power Div., 2040 N. Hawthorne Ave., Melrose Park, Ill.

Circle 41, inside back cover

COLLOIDAL DISPERSIONS — Booklet, 12 pp. Answers questions about physical and chemical characteristics, applications, production. Back cover lists technical bulletins available on uses of colloidal graphite and other materials. Acheson Colloids Co., Port Huron, Mich.

Circle 42, inside back cover

O-RING SIZES—Booklet, 16 pp. Outlines uniform numbering system for industrial O-rings and supplies a cross reference between this and former sizes. Also presented are cross-reference sizes for Government drawings of the AN, MS and CKCX series. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33.

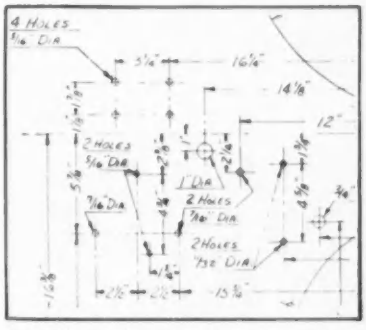
Circle 43, inside back cover

TEMPERATURE CONTROLS—Catalog 400, 8 pp. Describes over 160 standard

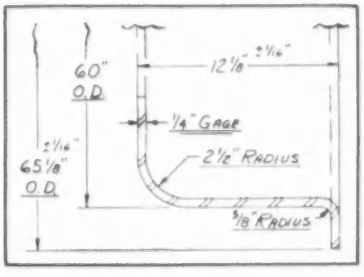
(Continued on page 133)

How accuracy is assured in every stamped component part...

Mechanical means in the stamping operation produce identical parts by tens, hundreds, or thousands. For this reason, once the die for any particular component is accurately produced, every part it helps to stamp is completely accurate with near-perfect tolerances—and without involving any appreciable dependence on operator judgement or skill.



Selection of materials from which stampings are produced involves a product that possesses uniformity. Freedom from raw material variables eliminates the necessity for additional processing of materials prior to producing stampings. Accuracy of stampings is predictable because they are produced to designed size and shape subject to predetermined tolerances. The only limits to the accuracy which can be stamped into a component part are the tolerances specified by the customer and the technical skill and experience of the supplier.



The greater accuracy afforded by the stamping method obviously leads to many important savings in the complete production operation—invariably means lower product cost. Because accuracy in stampings is identical—almost automatic—it involves no time lag, requires less man and machine hours to gain. At the same time, greater accuracy naturally means fewer rejects and less waste of raw material.

Gang-piercing Expels Errors

63 holes gang-pierced to near-perfect tolerances in 60" diameter stamped boiler doors

Exact dimensional sizing and accurate gang-piercing of all holes—eliminating chance of accumulative error—is a primary requirement in the dished boiler doors being produced for the Cleaver-Brooks Company. Equally important is close adherence to a tolerance of plus or minus 1/16" on diameter, and flat across the flange within 1/16".

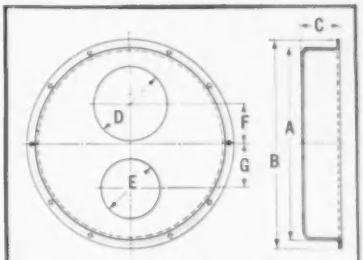
The close tolerances of the 63 holes in the dished boiler door assure the accurate mounting of standard controls, burners and blowers.

Identical Parts—Gang-piercing of the required holes in the Cleaver-Brooks boiler doors—involving a one-hit operation—insured identical dimensional and location accuracy of all holes at lower cost. Size and flatness of the one-piece stamped doors had to be maintained to tight tolerances even after the gang-piercing operation in order to guarantee perfect fit and draft-free closing seal.

The one-piece dished boiler doors are important components in a new line of Cleaver-Brooks boilers which feature forced draft and easy boiler access.

In terms of money—When other fabricating methods proved unsatisfactory and too expensive, Cleaver-Brooks turned to COMMERCIAL. Dies for the stampings were designed and produced by COMMERCIAL and the boiler doors are now turned out on a regular production basis on a 2000-ton mechanical press with an 8 x 16-ft. bed and a 30-in. stroke.

The close dimensional tolerances of the multiple holes in the boiler doors eliminate the need for further reaming. The exact spacing of all holes, which is completely free of *any* accumulative error, makes it possible to mount boiler accessories directly to the boiler doors without any assembly time lag. Also eliminated, thanks to gang-piercing, is the need for any flat surface facing before accessories can be mounted.



A	B	C	D	E	F	G
36	40	6¼	16¾	12⅜	7	8⅛
48	53	8½	20	16½	11¼	10¾
60	65⅛	12⅛	23⅜	18⅜	12⅝	14

Further savings—Other costly and time consuming operations formerly required—flame cutting, rolling rings, machining edges, welding, weld inspection, cutting holes, etc., not to mention the use of many expensive fixtures—have all been eliminated by the COMMERCIAL produced heavy stampings. Best of all, distortion which was formerly sometimes inevitable has now been replaced by near-perfect accuracy in every boiler door stamped for the new outstanding line of Cleaver-Brooks boilers.

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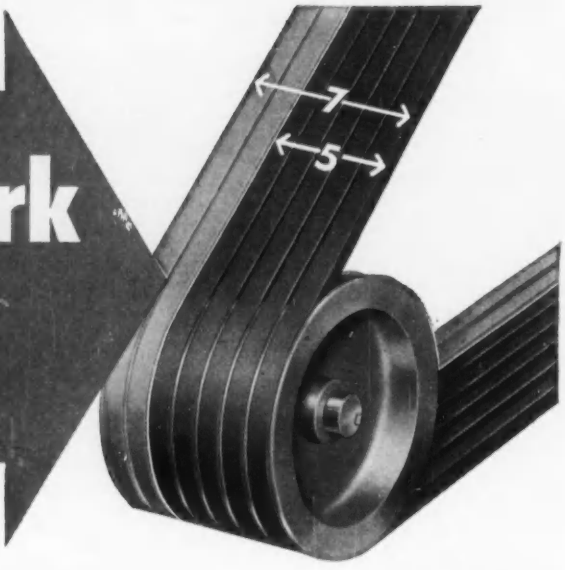
5 do the work of 7



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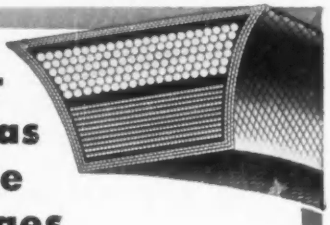

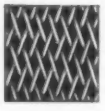

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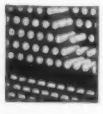

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types and models of local-mounted and remote bulb temperature controls. Contains specifications of each, limitations, applications, special features and variations for each control. Specifications are given in chart form. United Electric Controls Co., 79 School St., Watertown 72, Mass.

Circle 44, inside back cover

SOLENOID VALVES—Stock list 505, 8 pp. Contains prices, valve ratings, flow diagrams, illustrations, engineering data on valves available for immediate delivery. Automatic Switch Co., Hanover Rd., Florham Park, N. J.

Circle 45, inside back cover

SELF-LOCKING FASTENER—Circular, 4 pp. Describes principle; self-locking based on remolding of socket thread to contours of fastener's thread. Advantages, applications and several diagrams are included. Lock Thread Corp., 2832 E. Grand Blvd., Detroit 11.

Circle 46, inside back cover

EPOXY RESINS—Brochure, 8 pp. Summarizes the uses of epoxy compounds in various industries. Covers plastic tooling, potting and impregnating, coating and adhesion. A chart denotes formulations recommended for many characteristic applications. A checklist for storing, mixing and handling is included. Marblette Corp., 37-31 30th St., Long Island City 1, N. Y.

Circle 47, inside back cover

ANTIFRICTION BEARING SCREW—Catalog, 12 pp. Describes principle of operation, basic operations, advantages, available assemblies, basic test work and applications. Roton Products, Div. of the Anderson Co., Gary 40, Ind.

Circle 48, inside back cover

SELF-LOCKING NUT—Bulletin, 4 pp. Presents design and performance features, supported by dimensional specification drawings and table. Nut retains anti-friction bearings on spindles and shafts. Bearing Locknut & Machine Co., 4 Union Ave., Irvington, N. J.

Circle 49, inside back cover

POLYTETRAFLUOROETHYLENE BASE RESIN—Bulletin, 4 pp. Describes resin, advantages of parts molded from the material, and application advantages. Curves and tables compare new material with Teflon. Data on mechanical, electrical, chemical and thermal properties is included. Polymer Corp. of Penna., 2140 Fairmont Ave., Reading, Penna.

Circle 50, inside back cover

AC VOLTAGE REGULATOR—Data sheet APR1010, 2 pp. Describes operation of tubeless regulator. Gives electri-

(Continued on page 137)

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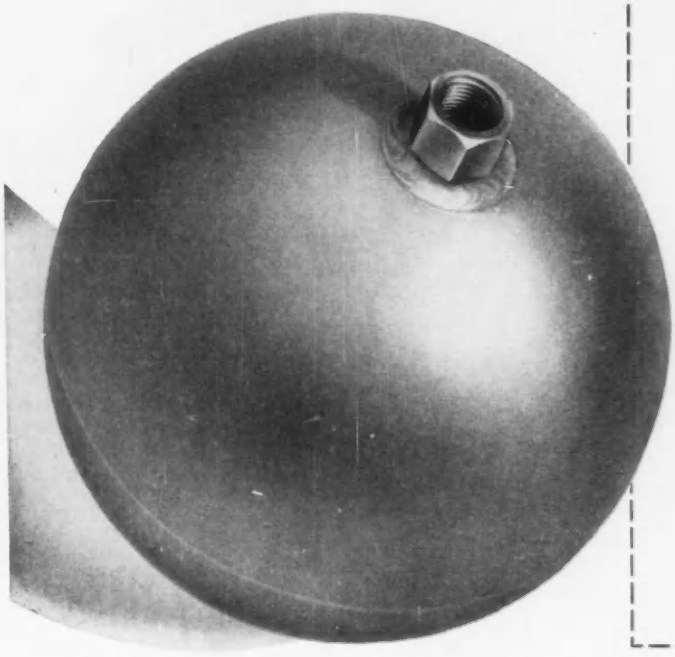

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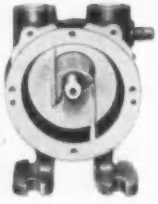

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cal and physical characteristics of unit. Sorensen & Co., Inc., Richard Ave., S. Norwalk, Conn.

Circle 51, inside back cover

SELECTIVE SPEED DRIVES—Bulletin 11-1, P1, 8 pp. Ac motor speed control, selective speed drives and their advantages, operation and application are discussed. Descriptions of several drives are included. Century Electric Co., 18th & Pine St., St. Louis 3.

Circle 52, inside back cover

SELF-GENERATING PHOTOELECTRIC CELLS—Bulletin 3216-1, 12 pp. Construction, performance characteristics, power output charts, electrical circuit diagrams for typical applications and suggested uses for line of self-generating photoelectric cells included. Vickers, Inc., Electric Products Div., 1815 Locust St., St. Louis 3.

Circle 53, inside back cover

COUPLINGS—Catalog 302, about 28 pp. Updated information on commercial reusable couplings, clamp-type couplings. Items are indexed for ease of reference. Gives description, specifications, dimensional drawings for all couplings. Also, data on threads, selection, methods for computing length of hose assemblies, laboratory testing equipment, catalog number explanation, and ordering information. Anchor Coupling Co., Inc., corner E. Church & 4th Sts., Libertyville, Ill.

Circle 54, inside back cover

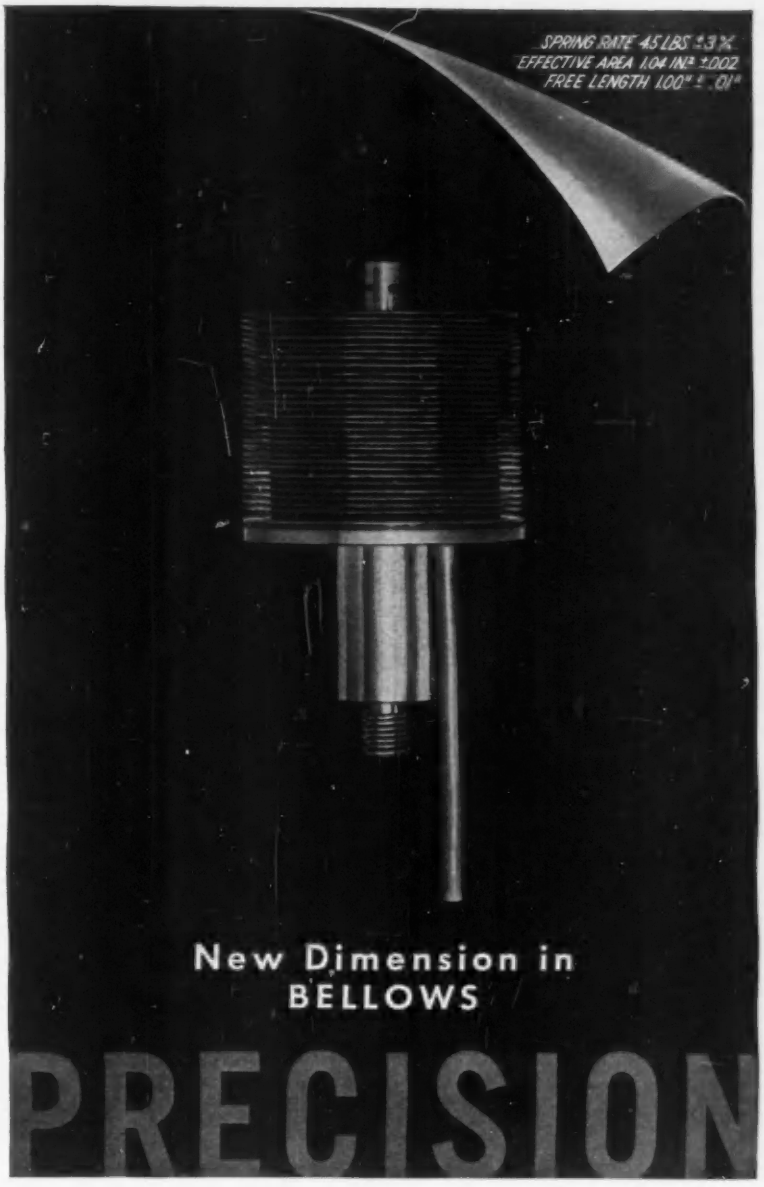
Letterhead Requests Only

Manufacturers who publish following literature ask that requests for copies be made on company letterheads.

INDUCTION MOTORS—Bulletin 104, 8 pp. Selection data on single and polyphase integral-hp induction motors to 20 hp. Motor construction, dimensional data and general descriptions are included. Leland Electric Co., Div. of American Machine & Foundry Co., P. O. Box 1060, Dayton 1, Ohio.

ENGINEERING FACILITIES — Brochure, 24 pp. Illustrates company's facilities for engineering, manufacturing, machining and assembling for military services and private industry. Lambert Engineering Co., 1100 Mackland Ave., St. Louis.

STAMPING MANUFACTURERS—Volume 8, 64 pp. 1958 Blue Book of Metal Stamping Manufacturers is a source list for buyer of stampings. Also includes suggested contract terms and conditions, lists of services, end products, facilities, honorary and foreign members. Pressed Metal Institute, 3673 Lee Rd., Cleveland.



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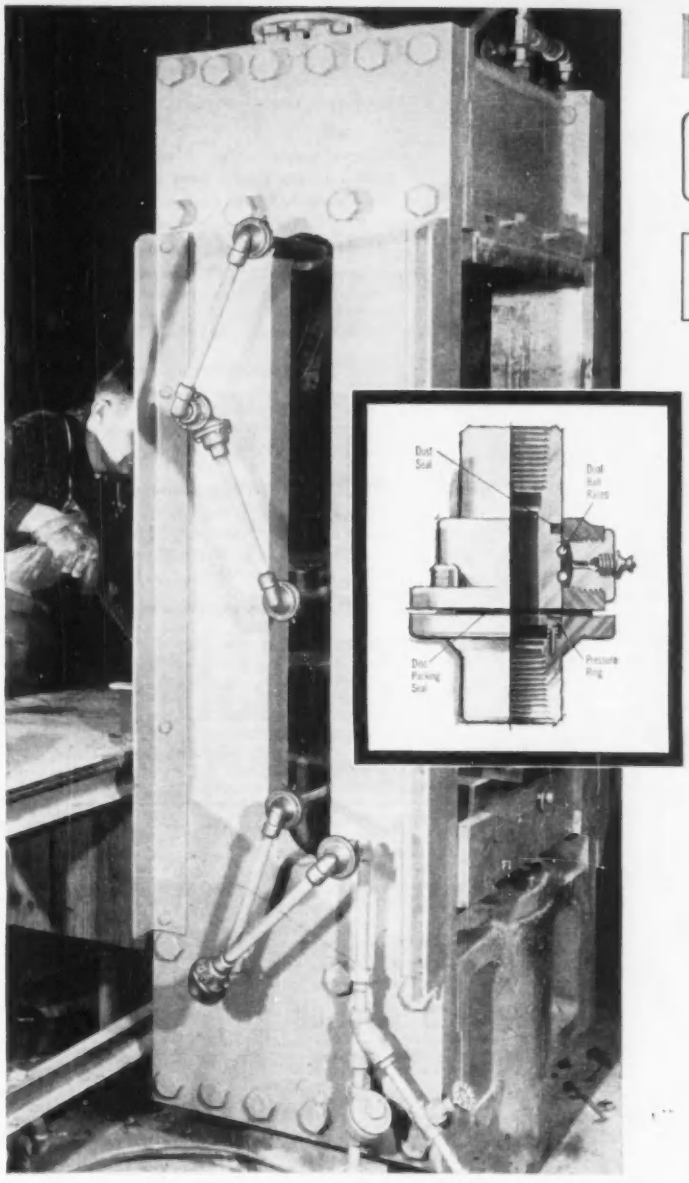

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Ideally suited on lines handling alternate steam and cold water flow—

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Chiksan Discpak Swivel Joints eliminate hose replacement costs, provide controlled line flexibility and end hose rupture hazards. A low cost seal is easily inserted *without* removing joint from the line. Savings in downtime and replacement costs quickly repay cost of installation. Don't delay, send for literature and name of your nearest Chiksan field engineer today.

Send for this informative Bulletin DP100. Contains detailed cutaway and dimensions of the complete Discpak line. →

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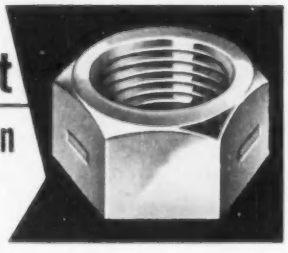
Centerlock Nut

saves production time... speeds application



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Tangents...

The Ability to Talk

A veteran reporter, according to a story we heard recently, said that the big men in business he'd interviewed were alike in three characteristics: courtesy, thoughtfulness, all-aroundness. The final characteristic is intriguing and needs explaining. He meant that they could talk with the experts on many subjects in rapid succession—indicating an ability to pick up, sort out and retain the essence of many diverse disciplines or fields.

Thinking back over some three decades of interviewing on a technical basis, we can support his statement. Sometimes the courtesy and thoughtfulness aren't evident—if they exist at all—but they seem more common at the top of the heap than they are down the line. The little man, or the overly ambitious one, is so busy thinking about himself that he hasn't much time for anybody else unless he can see personal advantage. Then he tends to go overboard—he fawns. And an occasional big shot, particularly the one who inherited most of his money or his position, is likely to be an overgrown pipsqueak.

My first experiences at interviewing were during college years, and the interviewers were people like Will Rogers, Glenn Frank, Herbert Hoover.

In all the years since, I recall only three instances in which a "big" man being interviewed lost his temper—and two of those were "calculated wrath" to avoid answering a question.

But the "little men" who have shown temperament are legion. This despite the fact that a technical editor is no Mike Wallace; there is no effort to explore a man's personal affairs or his ego. The technical editor is seeking technical data, nothing more. But he does develop a sixth sense that tells him when the interviewee's engineering is a little shaky or he's trying to cover somebody's inadequacy.

I remember the president of a little company in Philadelphia, who thought he had a secret method. When I asked pointblank if the secret wasn't thus-and-so, he blew a gasket and cursed me like a trooper. But his vocabulary wasn't particularly spectacular or ingenious, compared with that of the former sailor who (also) taught me pipe-fitting, so in a toe-to-toe cussing match, he lost. We were good friends the rest of his life.

Then there was the president of a small gage company who liked to swear over the telephone. He was domineering and hard-boiled, but extremely quiet-spoken to his intimates and anyone who proved to be as tough as he was. He would have been no match for the former general manager of a Canadian aircraft factory, who had a subtle approach. The latter always opened a conversation with some challenging and obscure remark. If his visitor caught the inference and reacted in kind, the plant was at his disposal; otherwise, there was no meeting of the minds. This is a refined variation of the blusterer, infinitely more sadistic.

So much for temperament. The big thing about big men is the ease with which they can talk with anybody on any subject. They are not experts, nor do they pose as experts, but they are familiar with a great many subjects—"generalists" rather than specialists. And their interests extend far beyond the requirements of their immediate jobs or the presumed limits of their particular fields. They seem to be able to anticipate the areas in which they should have information, and to "bone up" in preparation.

It is more probable, however, that they have minds which sort out and retain the needed information from all that is available. In addition, they have a lively curiosity.

Obviously, an executive must have the ability to talk, to explain to people above and below him what is going on. He must also have the ability to listen, and listening alone can give him not only information but also an opportunity to evaluate the speaker. And he should know which parts of what he knows can and should be told, and which parts should not. He soon develops the ways of turning questions and avoiding statements that shouldn't be made. Major elements in these techniques are unfailing courtesy and thoughtfulness.

Thus we come back to the original trio—courtesy, thoughtfulness, all-aroundness. —TJT

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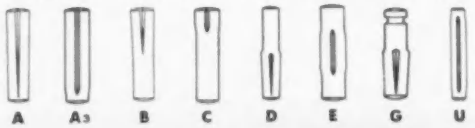

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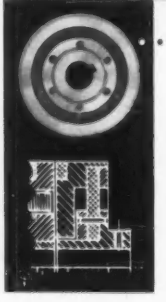

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DESIGN ABSTRACTS

Wood-flour-filled Urea

Still widely produced and sold in England, wood-flour-filled urea has been largely ignored in US in recent years. Yet presently available wood-flour materials are competitive with phenolic in price, equal it in hardness and inertness to chemical and pharmaceutical reagents, and surpass it in arc resistance and lightfastness. Physical properties of alpha-cellulose (paper slurry) and wood-flour-filled compounds are compared.

Abstracted from "Why Not Wood-flour-filled Urea?"; Modern Plastics, May 1958, 575 Madison Ave., New York 22.

Residual Stress in Flat Springs

Suggestions for the spring designer that will help to control residual stress (and, when possible, make it aid performance) are given. Effects of cold-working, stress-relieving, hardening, direction of stress are all discussed.

Abstracted from "Control of Residual Stress in Flat Springs"; The Mainspring, April-May 1958, published by Associated Spring Corp., Bristol, Conn.

Selecting Steels for Springs

Covers experimental results which indicate relationship between mechanical properties of spring wire and those of the finished springs. Describes how readily available data on ultimate tensile strengths of wire may be used to predict torsonial elastic limit of springs, and a table of ratios provided. These ratios are for maximum values and are to be used only with a safety factor. Curves based on ratios are provided for full range of manufactured wire sizes.

Abstracted from "Selection of Steels for Spring", by H. J. Elruendorf, American Steel & Wire Div., U. S. Steel Corp.; Metal Progress, April 1958, 7301 Euclid Ave., Cleveland 3.

For Studies of Wear and Lubrication

"Wear," an international journal devoted to fundamental studies of friction, lubrication and wear—and their application to engineering and industry—is being published six times yearly by the Elsevier Publishing Co., Amsterdam. Four issues have so far appeared (three in 1957, one in 1958). Contents range from physical-theoretical studies to industrial applications; both original papers and critical reviews are accepted. Contributors are from USA, USSR, Australia, Europe, India, Japan. Abstracts of current literature are also included Subscriptions ($15 per year) may be sent to D. Van Nostrand Co., 120 Alexander St., Princeton, N. J.

What's Your Patent IQ?

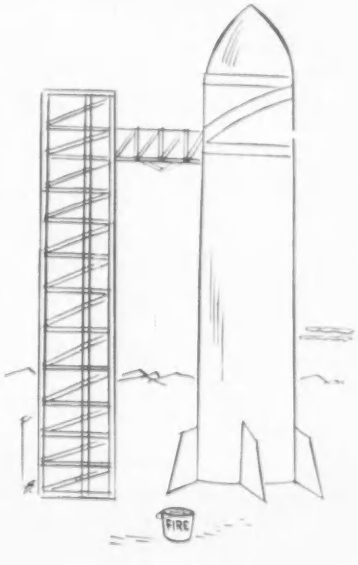
Quiz contains 12 questions aimed at determining reader's understanding of purposes, effects, structure and background of patent system.

Abstracted from "What's Your Patent IQ?", by H. L. Swenson; Allis-Chalmers Electrical Review, 1st Quarter, 1958, Milwaukee 1.

Preparing a Paper

The worst and most frequent sins of technical speakers are described. A method of writing out technical presentations and then reducing them to notes on small hand-held index cards is described.

Abstracted from "Reading, Rudeness and Redundancy" by Hiram Brown, Solar Aircraft Co.; Journal of Engineering Education, April 1958, Prince and Lemon St., Lancaster, Penna.



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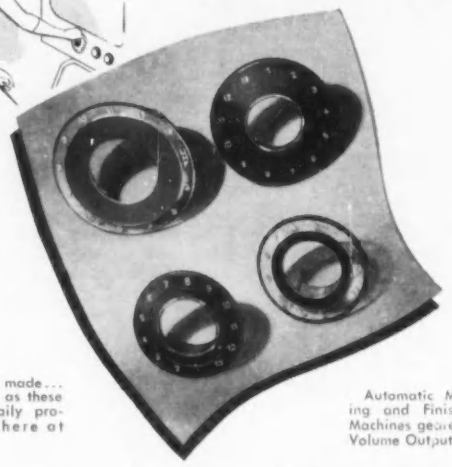

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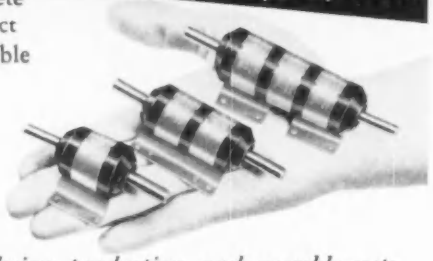

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Publication No. TID-3508, available from Office of Technical Services, US Dept. of Commerce, Washington 25, D.C., 11x7½, 37 pp. $1.

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(Continued on page 147)

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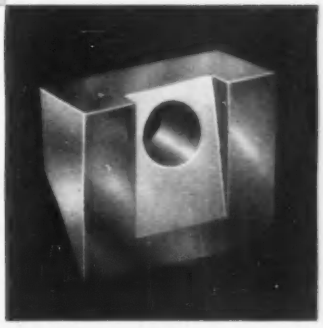

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it worth while to separate them. Zirconium, the more abundant, is now well known. Hafnium is just beginning to attract attention. Its characteristics are briefed in *PE*—Mar. 17, p. 69. This bibliography can serve as background information. It contains 134 annotated references.

Problems and Practices in Engineering Management

Published by American Management Assn., Inc., 1515 Broadway, New York 36. Paperbound 6x9, 132 pp. Price to members, $2.50; nonmembers, $3.75.

This special report contains 12 papers on engineering management presented at an AMA conference held in April, 1957, in New York. The papers cover such topics as the engineering shortage, engineering organization, recruiting, systems engineering, scheduling and budgeting.

Mechanical Vibrations

Austin H. Church. *Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York 16. 6¼x9¼, 275 pp. $6.75.*

Many of the vibration problems that arise in all branches of engineering can be dealt with by a rational application of the basic principles of vibration analysis. This book offers a rigorous treatment of these principles and, at the same time, lays the foundation for advanced work in this area.

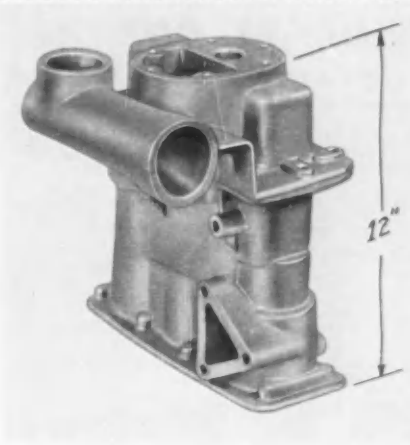
Using a mathematical and physical approach, the author stresses vector methods, the use of complex numbers, and Fourier Series. Specific topics covered include: forced vibrations of multimass systems, harmonic analysis, torsional critical speeds, electrical analogies, coupling action, balancing of angle or V-engines.

Statistics Manual

E. L. Crow, F. A. Davis, M. W. Maxfield, *US Naval Ordnance Test Station. PB 131483. Available through Office of Technical Services, US Dept. of Commerce, Washington 25, D. C. 5½x8, 288 pp., $6.*

The manual has been prepared for those who wish to use statistical procedures to improve the efficiency of their experiments. Emphasis is placed on (1) consulting with a statistician

(Continued on page 149)



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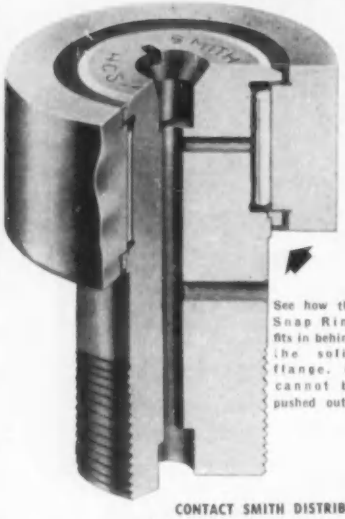

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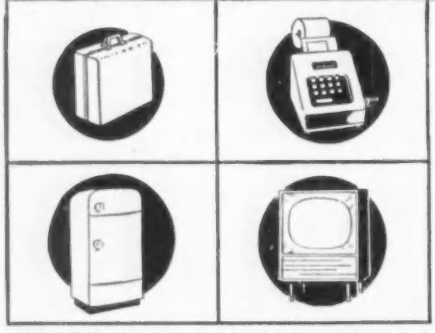

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(Continued on page 151)

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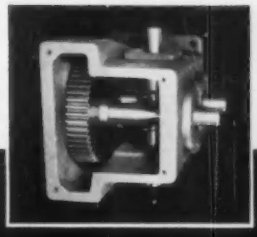

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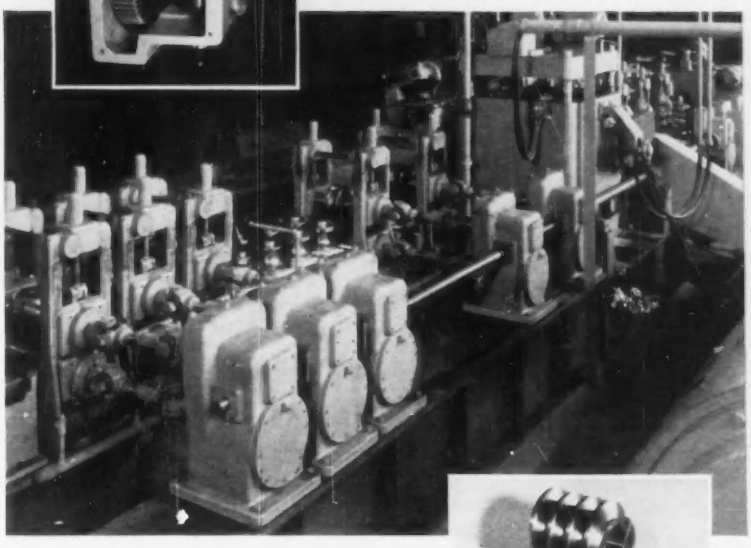

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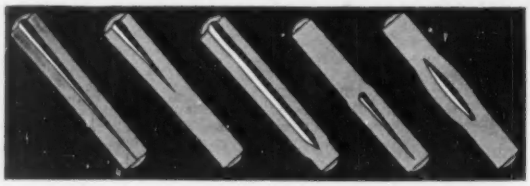

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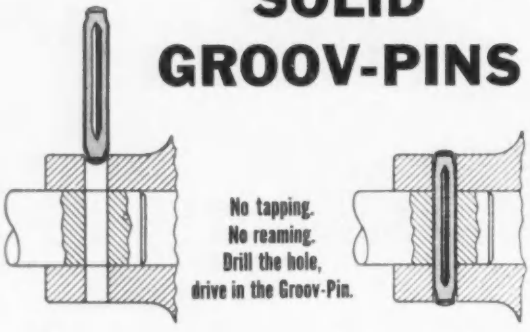

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techniques, capabilities, limitations and processing problems are different for each class of product, molded, extruded, lathe-cut and chemically blown sponge items are each treated in separate chapters. Each has its own set of charts, tables, illustrations, definitions.

Nickel and Its Alloys

NBS Circular 592, available from: Superintendent of Documents, US Government Printing Office, Washington 25, D. C. Paperbound, 7¾x10¼, 87 pp. $0.60.

This is another of the Bureau of Standards' careful, comprehensive publications on materials and engineering sciences. Originally published in 1921 and revised in 1924 and in 1950, it has now brought up to date again, with new data and a bibliography that runs through 1956 and into 1957. This publication belongs in every metallurgical and engineering library.

Analytical Kinematics of Plane Motion Mechanisms

JESSE HUCKERT. *Published by MacMillan Co., 60 Fifth Ave., New York 11. 7½x10¼, 209 pp,* $7.75.

This book is primarily designed for students taking kinematic drawing as well as kinematic theory. However, it may prove helpful to the practicing engineer who wishes to brush up on fundamentals of mechanism analysis.

Vibration Control

J. N. MACDUFF, J. R. CURRERI, *Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36. 6¼x9¼, 464 pp,* $9.

Written specifically for courses taught for machine-design majors, practicing mechanical engineers and designers, this text deals with some of the fundamentals of vibration control. Starting with fundamental principles, the book develops methods of analysis for classical vibrating systems and for systems of interest to the designer. In general, it introduces differential equations, the impedance method for steady state vibration, operational calculus and electronic analog computer for transient analysis; and some study of methods for analyzing nonlinear systems.

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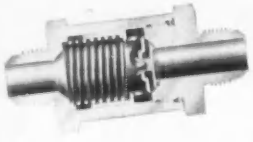
Mini-Valve — Regular Size Valve

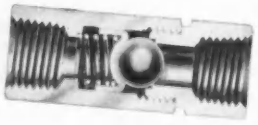
Save weight and space with Mini-Valves. They have same rated flow as regular size, but are only ¼ the size and weight. Good pressure drop characteristics. Temp. range −65° to plus 400°F. Operating pressure to 5000 psi. One-piece stainless steel body, in tube sizes 4 to 16 (¼" to 1" O.D.) Meets or exceeds requirements of MS MIL-V-25675. Port threading MS33514 flareless.



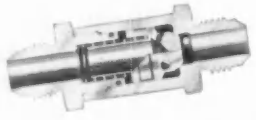
FREE-FLOW CHECKS

Extremely low pressure drop, with wide open flow. Molded elastomer seal and spherical seat prevent leakage at any pressure. Sizes ⅛" to 2" in brass and aluminum alloy up to 3000 psi, and stainless steel to 4000 psi. Opens at 2 psi. Temp. range −65° to 200°F. Pipe, internal straight thread and flared tube connections standard; MS33514 flareless available.

BALL CHECKS



Ruggedly constructed for intermittent non-shock hydraulic service up to 500 psi at temperatures −65° to 350°F. Sizes ⅛" to ¾". Brass, aluminum alloy, stainless steel. Pipe and flared tube connections.



HY-PRESSURE CHECKS

Built for continuous service in high velocity systems at pressures up to 5000 psi in steel and stainless steel, and 3000 psi in aluminum alloy. Low pressure drop. Metal-to-metal seal. Operating temperatures −65° to 250°F. Sizes ⅛" to 2", with pipe, internal straight thread and flared tube connections. MS33514 flareless available.

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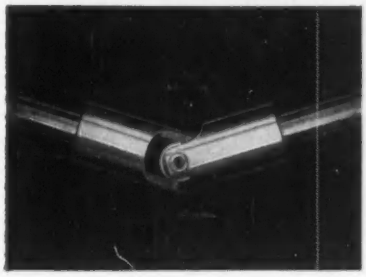
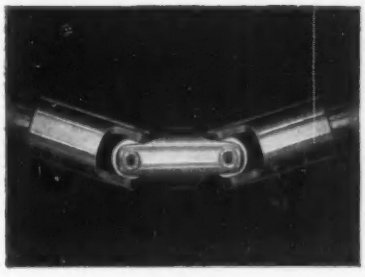


This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



Curtis engineers recommended a *double* Curtis joint, which reduced the angle to 17° per joint. Result: no overheating, improved efficiency, longer life.

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Design for Automatic Production
Product, and machine to make it are designed together for small or large quantities. June 23, '58, p. 81. Circle No. E 30

Electrical Control Enclosures
Guide for mounting and protecting controls to meet current standards. June 23, '58, p. 78. Circle No. E 29

Shaftless Ac Motors
New look at shell-type power packages. June 9, '58, p. 56. Circle No. E 28

Lubricating Instrument Ball Bearings
Guide to 42 modern oils and greases. Properties and performance charts. June 9, '58, p. 66. Circle No. E 27

Sandwich-panel Adhesives
The 14 most widely specified adhesives, with comparison table. May 26, '58, p. 56. Circle No. E 26

Coriolis Acceleration
Describes with equations how this force affects various components. May 26, 58, p. 72. Circle No. E 25

Semiconductor Rectifiers
Comparison of both germanium and silicon as low-cost rectifiers. May 12, '58, p. 89. Circle No. E 24

Midget Batteries
Specialized power packages where current or voltage needs can be kept low. May 12, '58, p. 72. Circle No. E 23

Sandwich-panel Facing Materials
Second of three articles gives data for selecting the skin material. Apr. 28, '58, p. 80. Circle No. E 22

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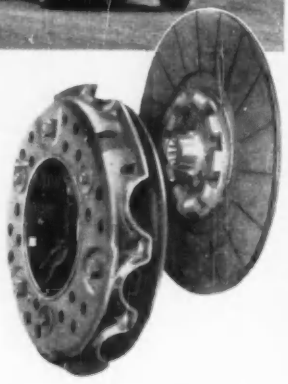

CLUTCHES
Are Adapted for Use with High-Speed Engines

Because modern construction methods require faster and faster delivery hauls with more and more cycles per hour, high speed engines are a must. The centrifugal force they develop presented a clutch problem—until ROCKFORD CLUTCHES were designed to minimize the effect of their multiplied degree of centrifugal force. If you want your heavy-duty machines to stay more hours ON THE JOB with less time IN THE SHOP—for adjustments and repairs—it will pay you to investigate the more torque grip, longer work life, and better heat disposal provided by ROCKFORD CLUTCHES.

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Shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS. Contains diagrams of unique applications. Furnishes capacity tables, dimensions and complete specifications.

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CLUTCHES

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Fan Selection
Three fan laws; charts, tables and sample problems. Apr. 28, '58, p. 92.
Circle No. E 21

Pressure Drops in Air Valves
Technique estimates pressure losses in a pneumatic system, component by component. Charts give K-factors for actual valves and fittings. Apr. 14, '58, p. 74.
Circle No. E 19

Which Adhesives for What
How to apply them and to what metals; with data tabulated for fast reference. Mar. 17, '58, p. 79.
Circle No. E 14

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"Let's not have any egghead discussion about Non Euclidian Geometry. In this By-Gawd Department parallel lines never meet!"

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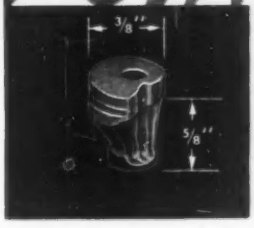


Output functions of this miniature precision cam change thousands of times, too . . . and the repetitive accuracy, because it is a mechanical control, remains constant.

The dimension "A" changes over 13,000 specified times as the ball follower passes over the surface of this precision Parker 3-Dimensional Cam. Actually the changes are infinite due to precision interpolation between specified stations.

If you have control problems where a mechanical control has advantages—where control space and weight factor or where environmental extremes affect accuracy—look to Parker for 3-Dimensional Cam Controls and dependable repetitive accuracy.

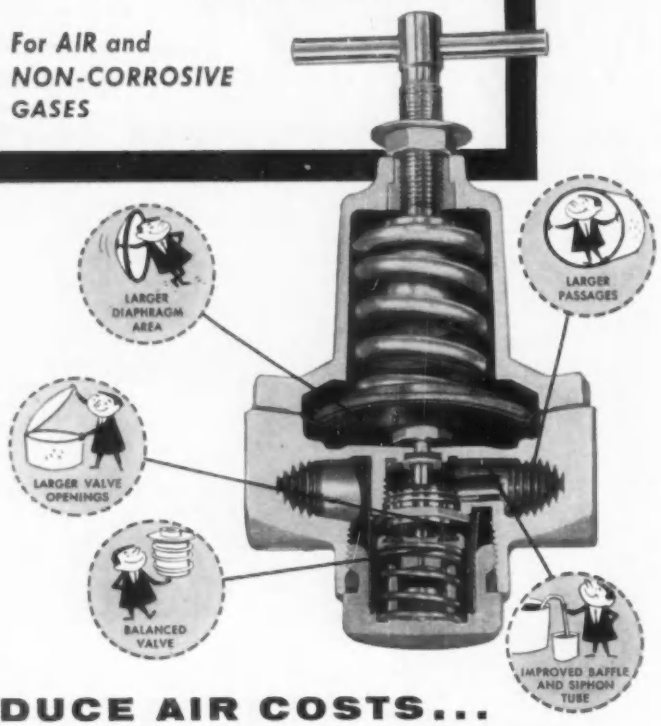
Send today for new literature on Parker designed and produced 3-Dimensional Cams.

THE PARKER-HARTFORD CORPORATION
CAM DIVISION
FRANKLIN AVENUE • HARTFORD, CONNECTICUT

by Parker

Norgren PRESSURE REGULATORS

For AIR and NON-CORROSIVE GASES



REDUCE AIR COSTS... CUT MAINTENANCE COSTS

Most air operated equipment has one pressure at which it operates most efficiently. Above that pressure, equipment wears excessively with no significant increase in output, and compressed air is wasted. Norgren Pressure Regulators reduce line pressures to the desired working pressure, produce better equipment performance and longer life, lower maintenance and compressed air costs.

Highly Accurate over a wide operating range.

Regulated Pressure Held Constant even with widely fluctuating line pressure and rapidly varying air flow.

Large Flow Capacity—a. Balanced valve construction; b. Large effective diaphragm area; c. Improved baffle and siphon performance; d. Large passages; e. Large valve openings.

Also regulators for water, oil, other liquids and steam.

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If it's Norgren...It's Dependable.

C. A. NORGREN CO.

3428 SO. ELATI STREET • ENGLEWOOD, COLORADO

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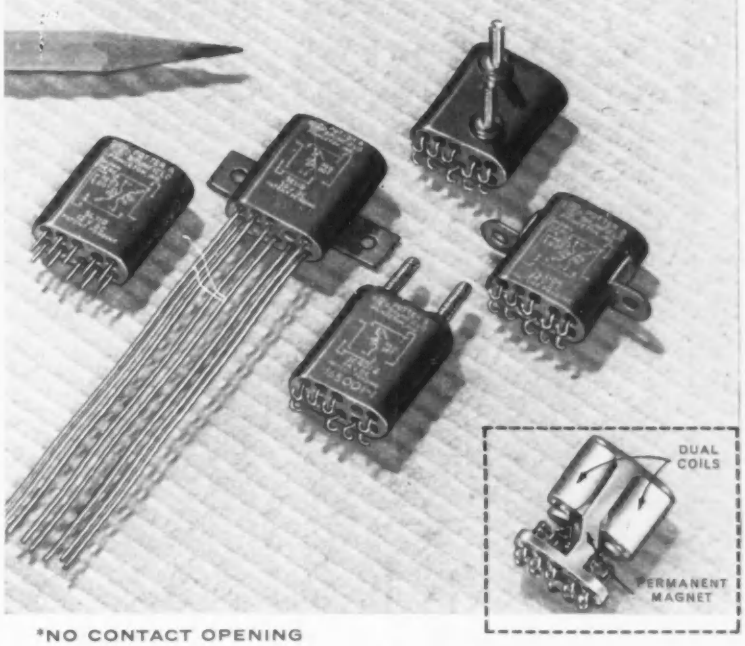
P&B MICRO-MINIATURE RELAYS LEAD IN

performance

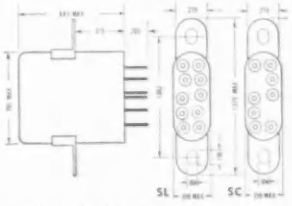
SHOCK: 100g* VIBRATION: 30g to 2000 cps*



*NO CONTACT OPENING

New P&B crystal-case size relays, the SC and the SL (magnetic latching), show amazing shock and vibration capabilities. They absorb shocks of 100g and vibrations 30g to 2000 cps. without contact openings!

One watt of power for 3 milliseconds operates either relay. Transfer time is unusually fast—0.5 milliseconds maximum.



SL—dual coil latching relay. Operates on a 1 watt, 3 ms pulse at nominal voltage. Permanent magnet latch locks the armature in either position.

SC—non-latching relay with series-connected dual coils. Operates on approximately 1 watt at nominal voltage. Coils must remain energized to hold the armature in the operate position.

SC and SL Series Engineering Data

GENERAL:
Insulation Resistance: 10,000 megohms, min.
Breakdown Voltage: 1,000 V. RMS.
Shock: 100g
Temperature Range: —65° C. to +125° C.
Vibration: 30g 55 to 2000 cps., 0.195" max. excursions from 10-55 cps.
Weight: 15 grams without mounting bracket.
Operate Time: 3 MS max. with 550 ohm coil @ 24 V. DC (SL: 630 ohm coil at 24 V. DC).
Transfer Time: 0.5 MS max.
Terminals: (1) Plug-in for microminiature receptacle of printed circuit board.
(2) Hook end solder for 2 #24 AWG wires.
(3) 3" flexible leads.
Enclosure: Hermetically sealed.
CONTACTS:
Arrangement: 2 Form C.
Material: Gold flashed palladium.
Load: 2 amps @ 28 V. DC, resistive; 1 amp @ 115 V 60 cycles AC, resistive.
Pressure: SC—16 grams min.; SL—20 grams min.
COIL:
Power: Approx. 1.0 watt at Nominal Voltage.
Resistance: SL—40 to 1400 ohms; SC—35 to 1250 ohms.
Duty: Continuous.
MOUNTINGS:
Bracket, stud and plug-in.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

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What does this mean to you? It means greater opportunities than ever before—in all fields. Home construction is expected to double by 1975. Power companies plan to increase output 250% in the next 20 years to provide the power for scores of new labor-saving devices. Clothing suppliers predict a one-third increase in 7 years.

With 11,000 new citizen-consumers born every day, there's a new wave of opportunity coming.

7 BIG REASONS FOR CONFIDENCE IN AMERICA'S FUTURE

1. **More people** . . . Four million babies yearly. U. S. population has *doubled* in last 50 years! And our prosperity curve has always followed our population curve.
2. **More jobs** . . . Though employment in some areas has fallen off, there are *15 million* more jobs than in 1939—and there will be *22 million more* in 1975 than today.
3. **More income . . .** Family income after taxes is at an all-time high of $5300—is expected to pass $7000 by 1975.
4. **More production** . . . U. S. production *doubles* every 20 years. We will require millions more people to make, sell and distribute our products.
5. **More savings** . . . Individual savings are at highest level ever—*$340 billion*—a record amount available for spending.
6. **More research** . . . *$10 billion* spent each year will pay off in more jobs, better living, whole new industries.
7. **More needs** . . . In the next few years we will need *$500 billion* worth of schools, highways, homes, durable equipment. Meeting these needs will create new opportunities for everyone.

Add them up and you have the makings of another big upswing. Wise planners, builders and buyers will act *now* to get ready for it.

FREE! Send for this new 24-page illustrated booklet, "Your Great Future in a Growing America." Every American should know these facts. Drop a card today to: ADVERTISING COUNCIL, Box 10, Midtown Station, New York 18, N. Y.

(This space contributed as a public service by this magazine.)

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Metallic.....Organic.....Decorative.....Protective

Tough new organosol coating sprays unique textured finish

Bronze plating duplicates eye-appeal of 24K gold finish

A copper-tin plate with the rich, brilliant appearance of 24K gold is easily obtained from the unique M&T Bronze plating process.

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Outwears textured baked enamels by 10 to 1

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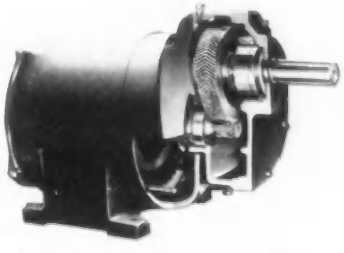

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